COMMISSION OF THE EUROPEAN COMMUNITIES
ECSC

Industrial Health and Medicine series No 18

Medical Symposium

Researches on chronic respiratory diseases

Industrial medicine

Luxembourg, 2 and 3 July 1975

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C O N T E N T S

3 July 1975

INDUSTRIAL MEDICINE

Current topics in the Industries of the Community

Chairman : R. FOEHR, Chief Medical Officer of the Medical Service, ARBED, Dudelange

Vice-Chairman : P. HENTZ, Head of the Division "Industrial Medicine and Hygiene"

OPENING ADDRESS

by P. RECHT, Special Adviser
Director of Health Protection
Directorate-General "Social Affairs"
Commission of the European Communities

Minister,
Ladies and Gentlemen,

It is a signal honour to welcome the Minister for Public Health and the Environment to the opening session of the Conference. At a time when European integration is trying to get its second wind, when the 1972 Paris summit and the meeting of the Council of Ministers held on 24 January 1974 have reaffirmed that social affairs must be given the place they deserve alongside economic affairs, we are very gratified that the Minister for Health of the Grand Duchy has signified, by his presence, that this Conference is more than a restricted interdisciplinary medical colloquium. Please accept our thanks, Minister, and rest assured that the doctors from the nine countries represented here today have great pleasure in being in Luxembourg, which for the last 2o years has been the recognised centre for the building of a healthy Europe.

I should also like to thank all the members of the political, social and economic world who by their presence here today have given evidence of their interest in our problems.

The ECSC has shown the way in this field, and we are indebted to the authors of the Treaty of Paris who, as a result of specific Articles which they wrote into the Treaty, have enabled the Commission to develop, side by side with the economic integration of the mines and the steel industry, a positive and realistic plan of action with a view to improving working conditions in the specific areas covered by the Treaty.

With the Treaty of Paris as its foundation, a coherent policy of study and research has been developed, which, for almost 2o years, has enabled many Community Institues and Centres to coordinate their work, to intensify their efforts and direct them towards the improvement of working conditions, the increased prevention of industrial accidents, and a fundamental and pragmatic approach to the diseases linked with the specific risks encountered in the ECSC industries.

I should like to welcome and give special thanks to the representatives of the socio-professional organisations and of governments to this conference, some of whom have been members of our consultative committees for almost 2o years. They can bear witness to the efforts made in successive research programmes since 1955, and they have seen the advent of outstanding scientific cooperation between our countries, research institutes and research workers, whereas in many fields European research is feeling its way and has still to overcome a double handicap : it is the sum of diverse efforts and yet must comply with divergent aims. I believe that the research workers who cooperate with us and are going to inform us of the results of their work at this meeting will bear me out on this point. It only remains for me to reassure them of our willingness to pursue the promotion of research in spite of the inherent difficulties of the present economic situation, which however, only serve to encourage us to get to the kemel of the real problems and to step up the translation of the results of their work into concrete terms.

We have willingly devoted this day to the research programme on chronic respiratory diseases. It may be thought with some justification that projects carried out over three years in some 5o research centres cannot be presented and discussed in detail in a single day. In fact, we have set ourselves a dual target : first, to enable the research workers to give as much information as possible to the professional and medical circles on the progress achieved and the concrete results obtained as well as the new guidelines evolved for future research. We hope you will be able to discuss matters freely and objectively, but we should also like to give the doctors and representatives of the employers and workers the opportunity to tell us about their current activities, bearing in mind their responsibilities in the organisation of health matters in their compagnies and in the implementation of legislation in matters of health and safety : this is the object of the second day.

Industrial medicine occupies a special place in a company's organisation and amongst the difficulties experienced there are obviously several which are due to gaps in our knowledge, which ought to give rise to research projects and scientific investigation.

Those doctors who have been working with the Commission for almost 2o years know better than anyone else the European aspirations of the Luxembourg departments; moreover, these doctors are in such a privileged position that they can see the instability in the current organisation of industrial medicine and react (in a spirit of progress and unselfishness) to the wavening which we can see at the present time.

The Commission also attaches great importance to the results of the exchanges of views on the second day which, I am sure, will be very profitable for those who, as a result of the new direction given to the social action programme, have had to extend powers and responsibilities in matters of industrial health and medicine beyond the scope of the ECSC.

Together we must work out a common policy in order to take concerted action on the health problems arising in the other sectors of the economy and to deal with special problems concerning migrant workers, working women or handicapped people capable of resuming work. In addition to alleviating the physical strains we must aim at humanising working conditions, improving the working atmosphere and environment, taking account of the psycho-sociological aspects, encouraging the worker to identify more with his own safety and giving him greater responsibilities by making him understand the conditions necessary for progress to a better quality of life.

This is a very wide-ranging programme and we shall find it increasingly necessary to ask (all of you) for your cooperation, emphasising once again that greater participation on the part of the social partners and more especially by workers is absolutely vital if any progress is to be made and objectives achieved.

From this point of view it is comforting to note that the foundations are already laid, thanks to the efforts of the research workers and industrial doctors, and the efficient cooperation of employers, workers and government officials.

Before I finish, I should like to reply to a remark which is often made about duplication or the lack of coordination of our work at the international level. I am able to give reassurances on this point since, as regards research, the Committee of experts of the national governments which, at our request, examines research programmes and projects, and follows up all studies carried out in the field of industrial medicine, is always consulted in order to avoid any overlapping with identical projects being carried out in their respective countries. Our excellent relations with the international organisations confronted with tasks similar to our own enable us to exchange information on our action programmes and the progress made.

I am especially grateful for the interest shown by the Council of Europe, the International Labour Organisation and the World Health Organisation, and I should like to thank Miss

Podesta, Dr Mastromatteo and Dr Arhirii for attending this meeting.

It is not sufficient to achieve free movement of men, goods and capital. Free movement of ideas is also essential. A meeting such as this must surely contribute to the achievement of this aim.

I wish it every success and declare the Conference on chronic respiratory diseases open.

WELCOMING SPEECH

by Mr E. KRIEPS
Minister of Public Health and the Environment
(Grand Duchy of Luxembourg)

I am extremely pleased to be able to welcome to this magnificient conference room more than 300 eminent research workers and experts, many of them doctors, and to wish them a warm welcome and an enjoyable stay in our city.

We are all aware of the topics to be dealt with in this Symposium, and these have just been most eloquently enumerated by the distinguished speaker who preceded me.

An intensive programme of research designed to cover a period of three years and consisting of 57 special studies carried out in 37 Research Centres and Institutes within the European Community is reaching its completion. The main problems investigated by the research workers were occupational pneumoconiosis and chronic bronchitis, which are very serious and distressing complaints and only too often result in premature invalidism.

More recent studies have covered a wide range of subjects, including the job profile of the industrial medical officer, training and promotion in paramedical professions, the introduction of industrial medicine to undertakings, the effects of noise, and particularly ergonomics.

In my capacity as Minister of Public Health and the Environment I take particular pleasure in offering my sincere congratulations to the organizers of these research projects and to all those who contributed to their completion. They have rendered an invaluable service to acountless number of people all over the world who have to work under hard and strenuous conditions.

Community researchers have set a very heartening example, in the fact that they do not work in a vacuum and do not possessively hide away the fruit of their labours. On the contrary, the results they have obtained are made available generally and every country in the world may make use of them if it so wishes, whatever its political regime or stage of development, and whether it be Western Europe or Eastern Europe, the United States and Canada or the USSR.

We derive a great deal of satisfaction, and a certain degree of pride, from the fact that Luxembourg, which houses the Community's Industrial Medicine and Hygiene Division, has been the starting point for all of these research programmes.

If I may, I should like to come back to a very important statement, referred to by the previous speaker, which says and I quote : ' The 1972 Paris Summit Conference affirms that economic expansion is not an end in itself, but should lead to an improvement in the standard of living and in living and working conditions.'

It therefore comes as no surprise that the organizers of the Symposium which you are about to embark upon have used this statement as an epigraph to their programme, since everything that will be said today or tomorrow will contribute towards improving the health and living conditions of the worker.

You will all be familiar with the definition of health which appears in the preamble of the World Health Organization. According to this definition, health does not only mean the absence of illness or disability, but implies a state of total physical, psychological and social well-being.

Whatever one's opinion of this definition and of about 3o other existing definitions of health, I am convinced of one thing, and that is that the absence of illness or disability is not sufficient to provide a valid, logical and objective definition of the concept of health.

In the context of the problems which will be dealt with during this Symposium, this concept of health sets us duties and obligations which all have a common aim : that of using our knowledge to the benefit of worker's health, and, as far as possible, of preventing illness and disability from ocurring at the workplace. This means that we must continue to humanize working conditions and to improve the working environment, not forgetting the psychological aspects which affect not only the worker as an individual, but also the members of his family and the surroundings in which he lives and develops.

In dealing with the working environment a great number and variety of factors are involved, such as the microclimate, temperature, humidity, noise, vibrations, lighting, pollution, dusts, gases, fumes, vapours and even human relations.

There is one discipline which integrates a multitude of others and its scope is expanding over the years as our knowledge becomes more explicit - a discipline which attempts to supply a firm scientific basis to the phenomena observed at the place of work, and which is an intrinsic element of all the topics featured in today's and tomorrow's discussions. I am referring to ergonomics.

The aim of ergonomics, according to the International Labour Office's definition ' is to achieve maximum mutual adjustment between man and his work.'

It is undoubtedly the terse but extremely striking definition given by Scherrer which provides the best rendering of the meaning and aim of ergonomics : 'The adjustment of work to man.'

If you will allow me, I should like to mention here a further definition, also referred to at a recent conference by my fellow countryman, Dr Raymond Foehr, who has rendered invaluable service to ergonomics, both nationally and internationally. This is the definition adopted by the 'Société d'Ergonomie de Langue Française' (French Language Ergonomics Society) : 'Ergonomics combines physiology, psychology and related sciences applied to human labour, with a view to achieving a better adjustment between methods, machinery and the working environment and man.'

Seen in this light, ergonomics is well on the way to becoming the keystone for all research into finding ideal environmental conditions at the workplace.

This aim has yet to be achieved and no-one can say when this will be.

But what we certainly can say, is that Symposia organized along the same lines as the one which will take place here today, clearly prove that we are all striving towards the same namely, towards the health of workers in a positive sense; that is, working to achieve his well-being, and then to improve his well-being.

With this in view, I should like to affirm that the European Community as a whole, and particularly in the work of its specialized departments of industrial medicine and hygiene, is paying a tribute of the highest order to the dignity of man at his work.

I wish you every success in this worthy enterprise.

INTRODUCTION

by Dr. U. VIDALI, Director
Directorate-general "Social Affairs"
Directorate Industrial safety and medicine
Commission of the European Communities

Mr. Minister, Ladies and Gentlemen,

As we have just heard, it is almost twenty years to the day since the ECSC High Authority convened the first meeting of the Producers' and Workers' Committee on Industrial Safety and Medicine.

As a result of that first meeting of both sides of industry, the ECSC's research policy on occupational safety and health was defined and applied on a continuing basis.

For twelve years, i.e. between 1955 and 1968, the ECSC High Authority was the only European institution which had its own safety and health policy for the whole range of occupational risks, making use of direct and active methods. Direct methods in that the Community contacted undertakings and scientific institutes directly. Active methods in that it called upon the initiative of researchers, undertakings, employers and workers to implement this policy.

Those of you who took part in the first stage of this work, the work carried out from 1955 to 1968, could give a better definition of that policy than I can. I think I may summarize things by saying that the intention was to link, on the one hand, a research effort conducted by experts in scientific institutes, clinics and laboratories and, on the other, an effort to improve working conditions, exchange practical experience and make practical improvements to safety and health in the undertaking. The link was thus established between scientific activity on the part of academic scientists and practical activity on the part of works medical officers, safety offices, workers and company heads.

Then, in the period beginning in 1968 with the creation of a single Council and executive Commission for the three Communities, when the three administrations of the ECSC, EEC and Euratom were merged, the departments responsible for occupational safety and health had to integrate the methods and powers of the three Communities, to compare their respective methods and to put forward new proposals which would enable them to assume responsibility for all questions of occupational safety and health in all sectors of the economy.

This endeavour developed within the framework of the social action programme via the following stages:

- in the first place it was intented to create working Community structures for all questions where occupational safety and health was the responsibility of the State. There are three such structures. The first is concerned with the mining sector, which comes under the control of the Ministries of Energy and the mining authorities in the relevant Member States; this is the Mines Safety and Health Commission - its powers were initially limited to the coal mining industry and extended in June 1964 to cover all mining activities, including the extraction of oil and natural gas.

- the second of these structures is concerned with the spheres of economic activity which depend in the Member

States on labour inspectorates; this is the new Advisory Committee on Safety, Hygiene and Health Protection at Work. This Committee has just been created by a Council decision and held its first meeting last week. I can assure you that it made an auspicious start to its work.

- At the same time both sides of industry were encouraged to take the initiative as regards occupational safety and health in their own spheres of activity. An active role is played here by the Steel Industry Safety and Health Commission, which celebrated its tenth year of activity a few weeks ago and whose experience has been used to encourage initiatives in other sectors such as agriculture, sea-fishing, transport and building. The initiatives being taken and developed are autonomous activities on the part of employers and workers within a sectorial framework aimed at producing codes of practice to improve occupational safety and health.

- A third category of activity is that of research. Here we have the example of ECSC research, with which we are concerned here and which I shall mention again shortly. In addition there is a general research policy to be developed on the basis of a programme which has just been adopted by the Council, but which is still a policy of the Member States and not of industry or employers and workers. It is designed solely to be carried out by scientific institutes and to yield increased knowledge, and the question of links with the practical world remains to be solved. ECSC research may be divided into two categories : on the one hand we have basic research which pursues practical objectives by means of constant participation by both sides of industry in the work of promoting such research - today's meeting is an example of this; on the other hand, we have research which has an immediate and direct effect on undertakings, aimed at modifying working conditions or subjecting new accident prevention or health protection equipment to in-plant testing.

Now that we have all these new working aids we can look to the future, with twenty years' experience behind us, and contemplate the responsibilities placed on us by the Community.

Our immediate task is to make good use of these aids to draw up and carry out a Community accident prevention policy. It will not be easy to make the transition from a stage where the provisions of treaties are implemented in isolation and with reference to single points of interest to one where this work is well organized within the framework of a set programme and then to move on to real policy with its own objectives and independent methods.

To achieve this we must reexamine the particular function of each of our traditional methods and see what these functions might be at the present time in the overall context. Today and all this week we shall be discussing ECSC research and on Friday the 'Producers and Workers Committee' will be meeting to consider prospects for the present and for the next five years of what is known at the moment as 'ECSC social research'. This covers four important fields:

1. respiratory diseases, the topic to be dealt with today and tomorrow ;
2. problems of job-suitability in undertakings, covering both ergonomics and rehabilitation;
3. technical problems of health in mines;
4. technical problems caused by pollution in the iron and steel industry.

We shall therefore have to define, in conjunction with the Producers and Workers' Committee, the objectives and methods of our research activities for the next five years. To this end we shall have to study the current needs of industry and of employers and workers in the ECSC industries. In the light of these needs we shall have to check the reasons underlying the Community's thinking and policy. Finally, we shall have to check the usefulness of the research. In my opinion research is of value if it furthers the objectives of occupational safety and health as laid down by employers and workers in our ECSC industries. For us, then, research is a tool to be used for observation, for action within the industrial system, a tool to be used as an instrument of policy by employers and workers, a tool which operates as far as possible within the framework of the undertaking and finally, of course, a tool which is used by the research workers and scientists working with us.

This list of points summarizes the present state of our research. The practical bias does not mean henceforth we shall be concerned only with ergonomics. There is still, and for a long time to come there still will be a need for medical research, clinical research, to make up a large proportion of our research activity. But it is clear that at the present time medical research is no longer isolated and no longer in a dominant position. It is also clear that medical research is only of value insofar as it is a factor of dialogue and change, working towards progress.

In this context of ECSC social research, we must therefore define the present function of the research being conducted on respiratory diseases, one of the four fields I mentioned just now. This is an extremely important area for us, since respiratory diseases still account for the majority of pathological conditions in workers in our industries, and in this area application is directly dependent on works medical units and the efficiency of the clinical units in which our workers are treated and can be rehabilitated when they are suffering from respiratory diseases. Once again we thus find, at this level and in the working programme for this conference, the same old duality between scientific work carried out in institutes and laboratories and more practical work carried out in industrial medical units. I think we must pay attention to this dual aspect of our endeavours for it also determines in part how much we can accomplish, how we can accomplish it, what use can be made of our achievments and which criteria should be applied in assessing the usefulness of all the research, all the work which we have carried out.

In this context, these few days of study and information are significant in three respects: first, we are about to put the finishing touches to the final results of the programme which is nearing completion; secondly, we must discover the potential applications of these results; finally, we must specify the conditions under which a new programme may be carried out; we must understand the relative emphasis we should give to the various activities to be promoted and the direction which new research initiatives should follow.

My departments are giving much thought to these three problems at the present time. I am therefore most grateful to you for coming here, for the work you are doing and for your cooperation in the course of the next few days.

PRESENTATION AND DISCUSSION OF THE RESULTS ON RESEARCH PROGRAMME (Coal and Steel) "Chronic Respiratory Diseases" (1971 - 1974)

1. BASIC RESEARCH

Rapporteur general : Prof. C. VOISIN (Lille)
Rapporteurs : Prof. E. VIGLIANI (Milano)
Prof. H. ANTWEILER (Düsseldorf)
Prof. P. DEGAND (Lille)

INTRODUCTION
(Prof. C. VOISIN)

Mr Chairman, Colleagues, Ladies and Gentlemen,

It is a formidable task to open this meeting by making a scientific assessment of the basic research into pneumoconiosis and chronic respiratory diseases carried out in the last three years.

The expression 'basic research' brings to mind theoretical work far removed from the practical concerns of industrial medicine and often difficult to grasp for all but a restricted group of specialists. In actual facts when the Research Committee studied the 'basic' research projects submitted for the 1971-74 programme, its policy was to accept only topics which were likely to have practical applications in the treatment or prevention of chronic respiratory diseases. However some of the projects which we are going to hear about form part of wider research with diagnostic or therapeutic aims. Four reports were prepared during yesterday's meeting of the researchers who had taken part in the 1971-74 programme :

- the first, which was to have been presented by Professor Könn, who is unfortunately indisposed this morning, is concerned with research into criteria of the toxicity of dusts and a study of the lesions in the respiratory system which they cause,

- the second, to be presented by Professor Vigliani, gives details of the relationships between respiratory infections, particularly mycobacterial infections, and the development of silicosis and pneumoconiosis in coal miners,

- the third report by Professor Antweiler will take stock of our knowledge of the preventive and therapeutic action of P 2o4 and its application to human subjects,

- finally Professor Degand will give the results of research into the natural defences of the respiratory system against noxious agents with particular reference to disorders in patients suffering from chronic bronchitis.

The first speaker was to be Professor Könn. Owing to a sudden indisposition he is unfortunately unable to be with us and I would ask our German colleagues to give him our wishes for a rapid and full recovery.

I must therefore stand in for him at very short notice and give you an account of research into the toxicity of dusts and the response of the respiratory system to their inhalation.

The teams led by Professor Klosterkotter and Professor Schlipkoeter studied the toxicity of mine dusts in terms of their composition and physicochemical characteristics. They employed very accurate methods using cell cultures, in particular cultures of alveolar macrophages, celles which defend the respiratory system against inhaled particles. The aim was to establish a relationship between the varying frequency of pneumoconiosis observed in different German coal mines and the characteristics of dusts collected in these mines. The work showed that quartz dusts studied in the laboratory were not all equally harmful to macrophages : their toxicity depended on electron structure and could be modified by chemical, thermal or mechanical factors. It was found from a study of dust samples collected in different German mines that a relationship could be established between the cytotoxicity of the particles and the geological age of the formation in which they occurred.

Working along similar lines, Mr le Bouffant and Mr Martin, of the Centre de Recherches des Charbonnages de France (Cerchar), demonstrated that the harmfulness of mine dusts was increased considerably by the presence of small amounts of quartz, of the order of 5%. Their experiments were carried out on rats and also showed that the part played by mineral particles other than quartz and coal found in mine dusts would repay study. The Cerchar team, on the basis of various in vitro techniques and using also intraperitoneal injections of dusts in animals, considers at the present stage of its research that several minerals are involved to varying degrees in the pathogenic action of mine dusts and that the toxicity of each cannot be considered in isolation because there are many interactions between the different constituents; total toxicity cannot be regarded as the sum of partial toxicities.

Dr Grailles investigated whether correlation existed between the anatomical type of bronchiolar lesions, bronchiectatic, or stenotic found in the lungs of miners with pneumoconiosis and the nature of the dust deposits in the lesions. This study, conducted on material obtained during surgery, used high-precission analysis techniques, including histodiffractography and infra-red spectrography, together with granulometric analysis of mineral particles in the lung tissue. This comparison of anatomical and physical findings confirms the decisive part played by the quartz content of dusts in the development of lesions in mixed dust pneumoconiosis. Whatever the type of bronchiolar lesion observed, however, there were wide individual variations in the dust parameters, the total dust burden being on average higher but not significantly so, in ectatic than stenotic forms. Finally, comparative study of several areas of the same lobe shows the existence of a considerable variation in the dust parameters, with the exception of the 'high quartz content' factor.

The last research project, led by Mr Le Bouffant and Mr Martin, was concerned with pulmonary emphysema. Using the electron microscope to examine sections of human lung obtained by surgical biopsy they found that there were two types of anatomical lesion.

The first (type A) showed considerable, parietal distortion, which seemed related to an initial change in the capillary endothelium. The second (type B) involved atrophy of the wall which primarily affected the connective tissues of the septum. It is interesting to compare these results with those found after intratracheal injection of papain in animals: the first stage involves enlargement of the centri-lobular air spaces and rupture of the interalveolar septa, which is fairly similar to the type A observed in human subjects. The lesions appear to be progressive and extensive, culminating after six months in atrophy and progressive rupture of the inter-alveolar septa, resembling the type B human lesions fairly closely.

We are thus gradually obtaining information on the different stages of the pulmonary lesions characteristic of pneumoconiosis and chronic bronchitis which is a vital step towards understanding the action of atmospheric pollutants at the workplace.

ROLE OF INFECTIVE, IMMUNOLOGICAL AND CHRONIC IRRITATIVE FACTORS IN THE ONSET AND DEVELOPMENT OF SILICOSIS

(Prof. E. C. VIGLIANI)

Numerous clinical and experimental observations, some dating back many years, indicate that infective factors and quartz-bearing dust very probably have a synergistic effect on the development of silicosis (Cesa Bianchi and Devoto 1911, Kettle 1924, Mavrogordato 1926, Irvine 1928, Gernez Rieux 1963, etc.).

In addition, the presence of gamma globulin deposits in the silicotic nodule in man (Vigliani and Pernis 1963) provides further evidence of the existence of important immunological reactions against infective antigens - or even exogens - or autoantigens.

In view of Heppleston's account (1967) of the various morphological aspects of experimental silicosis in SPF rats and conventional rats, particularly the reduced tendency for the pneumoconiotic lesions in the SPF animals to undergo sclero-hyalinization, we felt it would be useful to conduct a full and detailed examination of the effect of infective and immunological factors on the development of silicosis using the same experimental model.

1. Effect of infective factors

Female Sprague-Dawley SPF rats with body weights of approximately loo g received an intratracheal dose of 5o mg of hydrofluoric tridymite suspended in o.5 ml of physiological saline. Some of the rats were kept under SPF conditions while the others were transferred to a conventional breeding environment and divided in turn into two sub-groups, one of which did not receive any further treatment while the other was treated with CAF stearate administered orally (1 mg/day/rat). The animals were killed at 3, 6 and 12 month intervals from the beginning of the experiment.

A post-mortem study was made of the pulmonary microbic flora, silica content of the lung tissues and the type and extent of pneumoconiosis, by means of histological and histochemical methods and by quantitative analysis of hydroxyproline in the lungs.

The bacteriological studies showed a complete absence of micro-organisms in the lungs of animals kept under SPF conditions while in the case of animals transferred to a normal environment it was found that there was a marked increase in microbes, mainly staphylococci and streptomyces. Long-term antibiotic treatment led to a deterioration in the bacteriological state of the lungs, by favoring the appearance of a greater number of pathogenic components, particularly haemolytic streptococci. Determination of the lung tissue silica content, performed by colorimetry using ammonium molybdate, produced results which varied considerably from animal to animal, independently of the type of treatment administered. As determination was not carried out on the entire lung but on part of the lung tissue remaining after the removal of samples for histological studies and for hydroxyproline analysis, the variability of the results was probably due to an uneven distribution of material administered intratracheally.

The histological study showed marked morphological differences between the pneumoconiotic changes in SPF animals and those in rats placed in a conventional environment, whether or not they were treated with antibiotics.

These morphological differences were already in evidence after three months as it was found that the SPF rats exhibited non-hyalized and non-confluent macrophagic and fibroblastic granulomas associated with zones of alveolar inflammation with foamy cells and amorphous matter in the alveolar lumens where numerous scattered tridymite crystals remained, while partly confluent nodules exhibiting initial central hyalinosis were found in the conventional animals. There were however no alveolar inflammation zones in the latter and more definite concentrations of dust deposits were observed in the area of the lungs where nodulization occurred.

The morphological differences between silicosis in SPF rats and in conventional rats became even clearer after six months when the granulomas in the SPF animals were still almost completely free of fibrotic areas. After 12 months, the SPF animals showed a weak tendency towards hyalinosis, while the conventional rats exhibited large silicotic masses resulting from extensive confluence of individual nodules and frequent inflammatory foci sometimes resembling micro-abcesses.

The histochemical collagen colorations consistently showed a greater tendency to fibrosis in all the conventional groups of rats than in the SPF animals. In addition, the results of hydroxyproline determination showed that the mean concentration of hydroxyproline in the lung was always higher in the conventional animals than in the SPF rats.

Immunofluorescence revealed gammaglobulin deposits only in the conventional rats killed after 6 and 12 months. These were found in the silicotic nodules and plasma cell groups in the peribronchial and perinodular zones.

II Effect of immunological factors

Groups of SPF rats were treated intratracheally with tridymite combined with antigens (equine ferritine or peroxidase). The same antigens were later administered twice a week by aerosol.

The histological study performed on animals killed after 3 months and 6 months did not reveal any difference in the development of pneuconiosis as compared to that observed in the SPF rats studied earlier. It may thus be concluded that a single antigen combined with tridymite is not sufficient to bring about significant changes in the development of pneumoconiosis. It is very probable that only the presence of quantitatively more significant and qualitatively more polymorphons stimuli can bring about the marked differences in development that we noted between the silicotic granuloma in the SPF rat and the partly confluent sclerohyalinic nodule in the conventional rat.

The histochemical study of the antigens administered did however reveal a definite tendency for the inhaled antigens to become concentrated in the granulomas, particularly in the cytoplasm of the macrophagis present in the granulomas.

III <u>Conclusions</u>

At this stage of our research, we are able to confirm fully Heppleston's observation that the exposure of SPF animals to mixed bacterial flora found in a conventional environment changes the development of silicosis by promoting the tendency of the dust administered to become concentrated in certain areas where nodular formations with a more rapid sclerohyalinic development are formed. These changes in development may be ascribed to two factors, firstly to increased phagocytosis and lymphatic transfer of dust in lungs which are centres of inflammatory processes and secondly to the concomitant effect of antigen-antibody reactions.

The tendency demonstrated by us of inhaled antigens to become concentrated in silica granulomas suggests that the immune reactions are predominantly localized there.

Recent research has shown that immunological responses may be triggered in the respiratory organe, and which for a long time remain independent from the systemic responses (Henney et al., 197o) probably owing to the presence of immuno-active cells which become locally sensitized and tend not to migrate to other sectors of the organism (Waldman 1971a).

In the development of silicosis, the predominance of local immunological reactions to inhaled antigens over the general immunological state is also confirmed by the fact that when consideration is given to experimental silicosis induced in organic areas not directly influenced by infective agents, such as the peritoneon, the differences in the development of pneunoconiosis between SPF animals and conventional animals disappear (Weller 1974).

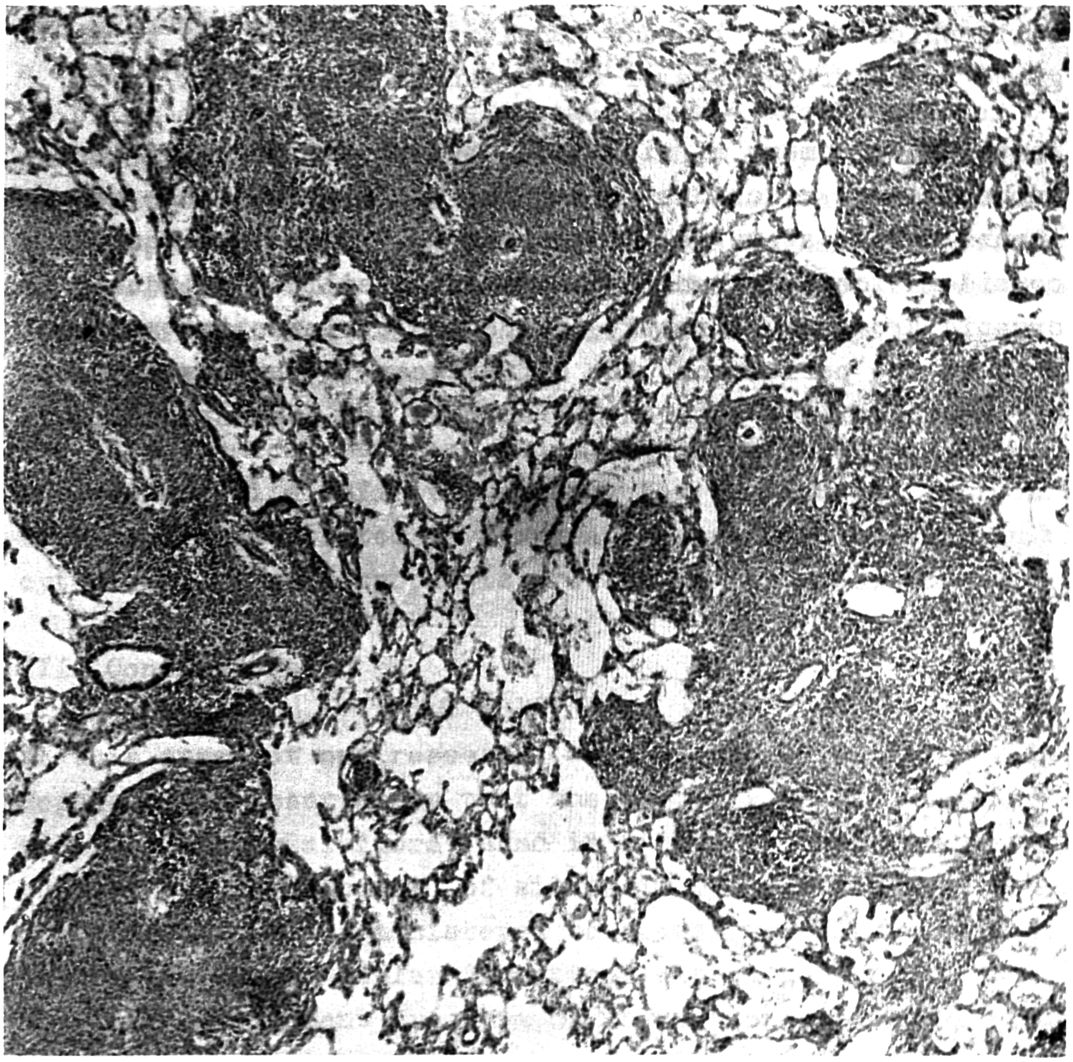

Fig. 1 - Lung of an SPF rat treated with tridymite and killed after six months. The granulomas have a structure similar to that described in rats killed after three months. In particular the fibro-hyalinosis phenomena are either absent or very insignificant and the alveolitic alterations persist. (x 66)
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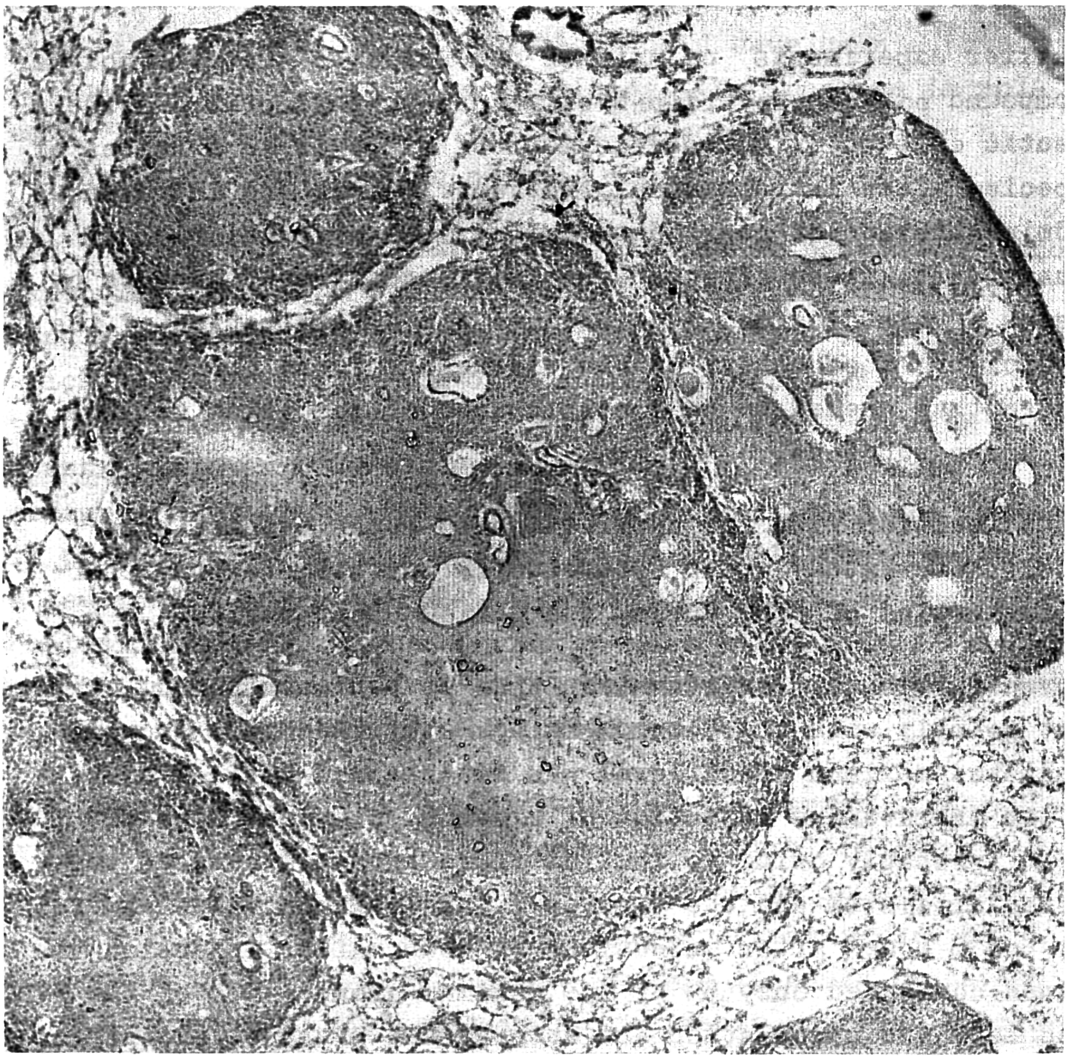


Fig. 2 - Lung of an SPF rat treated with tridymite, transferred to a conventional environment and killed after six months. The tendency towards confluence and, at the centre of the nodule, a wide fibro-hyalinic area containing numerous tridymite crystals can be clearly seen (x 66)
Research No 624o-oo/4/oo9

TREATMENT OF SILICOSIS WITH POLYVINYL PYRIDINE-N-OXIDE(PVNO)

(Prof. H. ANTWEILER)

Earlier experiments on animals demonstrated that the polymer compound polyvinylpyridine-N-oxide had prophylactic and therapeutic effects on the development of fibrosis in a number of species after intratracheal, intraperitoneal and intravenous administration of quarz dust suspensions or inhalation of quarz dust. These effects were confirmed by many authors by means of histological examinations and determination of the hydroxyproline content of the tissues. For the first time there thus seemed to be a real chance of combating silicosis in human subjects.

In connection with its application to human beings, the Schlipköter study group (Düsseldorf) investigated the pharmacokinetics of PVNO during the period under review.

Investigation of the retention time in patients'blood, carried out jointly with the Ulmer Working Party (Bochum), showed that the maximum blood level was not reached until 4 hours after intravenous injection of a normal clinical dose of PVNO (probably owing to initial fluid exchange between the vascular system and the tissues); this maximum value was fell by 50% 8 hours after injection; 24 hours after injection the blood contained only 5% of the maximum amount; 95% of the PVNO had left the circulation and entered the tissues, except for a small proportion with smaller molecules which was excreted by the kidneys.

Because of the importance of choosing the correct dosage and frequency of injection, pulmonary storage of PVNO was examined in the rat . It was found that PVNO could not be detected in the lungs of normal animals only a few days after intravenous injection. If, however, the rats had received intracheal quarz injections a few days before, PVNO remained stored in the lungs for some weeks. The amount stored was many times greater than that which could have been adsorbed on the surface of the quarz particles. The increase in pulmonary macrophages caused by quarz is considered to be a morphological correlation of this storage.

The increase in phospholipids, in particular phosphatidylcholine, is today regarded as the first chemically detectable lung change in the development of experimental silicosis, which leads over a period of months to a marked increase in the original phospholipid content. Experiements on rats demonstrated that if PVNO is administered as a preventive measure, a few days after injection of quarz dust the increase in phospholipids is checked and that a single therapeutic dose a few months after administration of quarz reduces the phospholipid content after one year to only 3o to 5o% of that of control animals which have not reveived PVNO. The therapeutic effect of PVNO was therefore considerable.

The Düsseldorf group also investigated the causes of the shock symptoms observed in isolated cases on initial and repeated administration of PVNO. Since the reaction to initial administration could not be due to allergy, experiments were performed on animals to investigate whether it could be caused by the liberation of histamine. Experiments on rats, guinea-pigs and cats in vitro and in vivo gave no indication of such liberation. Indeed PVNO reduced the liberation of histamine from mast cells caused by a powerful histamine liberator (compound 48/8o). In experiments on guinea-pigs and rabbits it was not possible to detect anaphylactic or circulating antibodies against PVNO with a normal therapeutic or minimal PVNO dose. The reason for the shock symptoms is probably that injection of PVNO of the molecular weight normally used for clinical experiments in concentrations of up to approximately o.5% leads to erythrocyte aggregation.

The erythrocyte aggregates probably trigger off a reflex lowering of blood pressure in the capillary zone of the lung. This can be avoided by slow infusion of PVNO diluted in saline solution.

Könn (Bochum) carried out post mortem histological examinations of five lungs from men suffering from anthracosilicosis been treated with a total of 31 g PVNO over a period of 34 months. No signs were found of changes in the silicotic tissue structures or toxic damage to tissues from PVNO.

Latest tests (in conjunction with Huntingdon Res. (Huntingdon) on baboons which were exposed to high concentrations of quarz, have shown only slight inhibition of the effects of quarz by PVNO. This confirms results obtained by Webster (South Africa) who also found only slight preventive and curative effects with normal clinical dosage of PVNO in baboons. Higher doses of PVNO produced distinct, although not spectacular, inhibition of silicosis development. No troublesome side effects or malignant tumours occured.

The Ulmer Working Party (Bochum) experimented on rhesus monkeys, which inhaled a coal/quarz mixture for four years. Exposure was halted for six months and then they were injected twice at intervals of 8 days with 15o mg PVNO in physiological salt solution. There were no incidents during injection. Histological examinations showed typical silicotic tissue changes. No differences from control animals not treated with PVNO were established, nor any differences in lung weight, oxyproline content, total dust and quartz dust, the blood gas levels or pulmonary compliance.

Tests on patients in various hospitals have shown that no serious side effects occur with 4 years' intravenous administration of PVNO. Work carried out in collaboration with Prügger (Tobelbad) showed regression of tissue changes visible on X-rays in 2o severe cases of silicosis treated with PVNO. Initially rapid development of tissue changes in 8 less severe cases was halted by PVNO treatment. More extensive tests with minimal forms of silicosis are still under way.

A critical summary of the findings to date on the effects of PVNO might be as follows :

There is evidently a pathogenic difference between fibrogenesis following a single intratracheal injection of a relatively concentrated quarz dust suspension and that following long-term inhalation of low quarz dust concentrations. Collagen which has developed slowly appears to be affected less by PVNO than collagen which has developed more quickly. Prophylactic or curative effects of PVNO are therefore much more likely in rapidly developing cases of silicosis following inhalation of pure quarz or dusts with a very high quarz content. The PVNO doses hitherto used in clinical tests should be increased in order to achieve better therapeutic results.

THE DEFENCE MECHANISM OF THE RESPIRATORY SYSTEM

(Prof. P. DEGAND)

This report is concerned with four contracts for basic research into the defence mechanism of the respiratory system.

This defence mechanism consists of several processes :

- mechanical clearance of the respiratory system;
- cellular and humoral defence;
- finally the part played by bronchial secretions in the microenvironment of the cellular elements and in the microphysiology of the mucosal surface of the bronchi.

A common aim of these projects is to develop methodologies based on fundamental data and suitable for the study of the processes mentioned above.

First the study of bronchopulmonary clearance :

The essential aim of the work of Dr Dechoux and Mr Le Bouffant is to develop, within CERCHAR, apparatus to investigate elimination of inhaled particles in man. Results obtained with laboratory animals (rats, cats and monkeys) show great differences in the clearance rates for inhaled particles (15 days in cat, 25 in rat, 4oo in monkey). Results from studies of this type, therefore, cannot easily be applied in man, hence the reason for developing apparatus for the controlled inhalation of particles of hematite labelled with iron 59 and known to be smaller than 5/u.

Studies with 15 normal subjects have shown :

- great variability in the percentage of particle retention between subjects;
- the existence of two phases of clearance :
  - a rapid phase with a maximum duration of 2 days corresponding to bronchial or ciliary clearance
  - a slow phase lasting at least loo days corresponding to pulmonary clearance.

The second phase also varies from subject to subject and the average duration for the 15 normal subjects was 369 days.

Experiments on animals have shown that exposure to dust significantly delays the clearance of labelled particles and that if dust exposure is prolonged, pulmonary clearance becomes virtually nil. This technique is now being applied to coal miners to assess their clearance capacity. A comparative study with non-miners will attempt to show the influence of emphysema, asthma and chronic bronchitis on these clearance factors.

Let us now consider the results obtained by Professor Voisin's group :

The difficulties of interpreting results obtained during clinical studies when using antimicrobial vaccine administered systemically or locally in order to prevent acute infectious episodes during chronic bronchitis led this research group to make an experimental study of the cellular defence mechanism of the respiratory system against viral and bacterial infection.

To tackle these problems it was necessary to develop an in vitro experimental model reproducing in microenvironment of the alveolar macrophages, i.e. living in the gaseous phase, reconstituting the endoalveolar and endobronchial environment in which these cells develop.

The technique chosen was the survival of macrophages placed on porous membranes on the surface of a tank filled with nutritive liquid.

Optical microscopy, electron microscopy and study of phygocy-tic and bacteriocidal activity showed that the physiological properties of the macrophages were extremely well preserved under these experimental conditions. This technique has demonstrated the beneficial effects of the products of alveolar lavage on the bacteriocidal potential of these cells. Similarly it was possible to demonstrate the cytotoxic action of the influenza virus and the unfavourable effects of gaseous pollutants on the macrophage defence system : e.g. exposure to an atmosphere enriched with NO_2 whether or not associated with airborn water droplets.

Mr Pernis's group studied the effect of atmospheric pollutants on the humoral defence capacity of the respiratory system. They compared the effect of coal or hematite particles and SO_2 on the biosynthesis of antibodies in rabbits, since the lympho-paryngeal organs of these animals can be directly exposed to pollutants. It was found that

- SO_2 had an immunosuppressant effect
- but the inhalation of dusts (coal, hematite) encouraged the biosynthesis of antibodies.

The last contract concerns the biochemical study of bronchial secretions. The aim was an improved knowledge of the principal components of sputum. The group at the proteins unit of INSERM (Lille) concentrated on the study of the bronchial mucins of the secretory A immunoglobulins and of broncho-transferrin. Important conclusions were obtained

- a classification of mucins in accordance with their functional activity. e.g.:
  - . the blood group activity of neutral mucins,
  - . the inhibiting effect of polyaniotic mucins on broncho-

spasm caused by bradykinin,
the interactions between secreted mucins and proteins leading to the formation of macromolecular components which make up the fibrillar structure of the secretions.

This structure is directly related to the physical properties of the viscoelasticity of the bronchial mucus which are essential to the efficiency of the bronchial cilia. A joint study with Professor Sadoul's group in Nancy showed correlations between the biochemical components of sputum, rheologic qualities and the functional role of the mucins.

This group is also attempting to develop a simple method which would provide a better definition of a patient's state of bronchial secretion and improve our understanding and treatment of bronchial hypersecretion.

The study of secreted proteins has led to a better knowledge of the secretory defence mechanism against enzymes released during superinfection states. This is particularly concerned with the problems of proteins with antiprotease activity such as α_1 antitrypsin and antichymotrypsin.

I would point out in conclusion that all these important results come from basic research aimed essentially at producing accurate methodologies for the study of the different defence processes of the respiratory system.

CONCLUSIONS

(Prof. C. VOISIN)

In drawing conclusions from the sum total of basic research carried out under the 1971-74 programme, a first point must be made : the scientific work which has been reported to us certainly complies with the original objectives of the Research Committee, that is it has obtained results with obvious practical applications in the treatment or prevention of occupational respiratory diseases.

Many problems have yet to be solved, however.

In the field of therapeutics, Professor Antweiler stressed the need for caution in the use of P 2o4 to treat miners suffering from pneumoconiosis. Though this drug has raised great hopes because of its action on experimental silicosis, it has yet to show that it is free from side effects and is effective in mixed dust pneumoconiosis before it can be used on human beings. Only further laboratory and clinical research will be able to provide a satisfactory answer to that difficult problem.

Similarly you will have noticed that the treatment of chronic respiratory diseases, in particular chronic bronchitis, cannot achieve maximum efficacy unless it is properly adapted to the physiopathological phenomena occurring in the diseased bronchial mucosa. The biochemical and immunological approach to these problems must continue; it is indispensable to the development of new approaches in this complex field.

The principal emphasis in occupational respiratory diseases must continue to be on prevention. Whether the disease be pneumoconiosis, emphysema or chronic bronchitis we know that the destruction of lung tissue which accompagnies these diseases cannot be repaired. Action must be taken before these irreversible anatomical disorders develop and result in disabling chronic respiratory insufficiency.

We should concentrate on two aspects and orient our action accordingly in future :

- Knowledge of the actiological agents and their action on the respiratory system. This is a vast field of investigation where research merits all the more attention since new hazards are likely to appear in the next few years.

- As a corollary, better knowledge of the natural defences of the respiratory system and their disorders is required. This research has two objectives, firstly to improve understanding of the initiating factors in these diseases and thus to improve our methods of prevention and early treatment of initial lesions. Secondly it aims to discover why workers do not all have the same physiological reactions and liability to develop occupational respiratory disease. It has long been known that workers are not all equally sensitive to the effects of exposure to toxic dusts or gases. The reasons for this individual susceptibility are better known today but further research is necessary to improve the guidance given to workers and to minimize the risks to those most sensitive.

As you will see, basic research has an immense field to investigate. The teams of European researchers who have proved their competence and efficiency during recent programmes are ready to continue their work within the spirit of the Community which Dr Vidali has just described and to provide the best possible safeguards for workers' health.

DISCUSSION

Prof. Symanski

Prof. Vigliani has presented some very interesting results of experiments showing an acceleration in the development of silicosis in clinically infected laboratory animals. I should like to know his opinion on this regard to man. Does he agree with Norvid, who emphasised the fact that massive fibrosis can be the result of secondary infection of silicotic lungs?

Prof. Vigliani

I think Norvid's research is particularly interesting and instructive. Clinical observation has shown that the silicotics, who have frequent pulmonary infections, usually have more serious forms of silicosis tending towards massive forms. There is no doubt that if the lungs can be kept free of infaction, silicosis develops less rapidly and is less serious. In this respect Norvid's observations confirm our findings in animals. Animals having greater pulmonary bacterial flora than is normally found develops more serious and obvious silicosis. Similarly, analysis of the amount of oxyproline revealed a significant excess amount of collagen. As a result it seems from a clinical point of view that one of the most important aspects in the prevention of silicosis would be the protection of people exposed to dust against infections, both bacterial or viral and tubercular, which could affect the lungs.

Prof. Voisin

Dr Baffye and Dr Dechoux have put to Prof. Antweiler a series of written questions about P2o4. These questions pose the following problems :

1. What is the risk of accumulation and retention of P2o4 in the organism and in particular of its carcinogenic effect, especially if the doses injected must be increased in order to increase or to maintain its potency?
2. How many people have in fact been treated with the product and for how long?

Prof. Antweiler

1. With regard to the product's toxicity and in particular its carcinogenic effect, I believe I can give a quite definite answer in saying that no such danger exists with the dosage used so far in clinics and with the intravenous method of administration. Numerous studies have been carried out on this aspect, particularly by Mr Schmele who is a specialist in these problems. He worked on different types of animal with different dosages which included prolonged administration of the product to rats over a period in excess of two years. He found no carcinogenic effects. Perhaps reference is being made to the earliest research on the product in this sphere; local neoplasm appeared in rats following repeated subcutaneous injections. But such a phenomenon can very often occur with a great number of other chemical substances. Anyway, as far as the intravenous method of administration is concerned, the product proved to have no toxicity whatsoever. One can even go as far as to say that if the present dosage were to be increased in the future, the product woulu still have no carcinogenic effect.

2. In answer to the second question, on the number of people who have in fact been treated with P2o4 and for how long, I think that a total of about 6o to 8o people have been treated in Germany and Austria. About 2o of these received treatment for four years.

Prof. Worth

In recent years we have shown a keen interest in the use of P2o4 on man and it must be said that the barometer of our hopes and expectations has fluctuated greatly. I believe that the reason is the failure to distinguish adequately between silicosis caused by pure quarz dust and pneumoconiosis caused by mixed dusts, which can be found in coalminers. What is true of pure silicosis is not necessarily true of mixed silicosis. Perhaps Dr Antweiler could give us his opinion on this ?

Prof. Antweiler

I have clarified for you the observations which were made in Austria on workers exposed to granite dust. I do not know whether sandblasters have yet been treated. But in any case we can recommend P2o4 for the former. At the present time we could not, however, make the same recommendation for coalworkers' pneumoconiosis. What has so far been found is far too uncertain from the radiological point of view. You know yourselves how long it is before a radiological decision can be reached on the progress or stabilisation of pneumoconiosis. The same difficulties occur in the assessment of a possible regression of the disease. However, we have found in animals that the age of the collagen tissue - that is, in clinical terms, the length of time that the radiologically visible changes have been present - is a decisive factor in the prognosis of the success or failure of the treatment.

Prof. Vigliani

I should like to know the attitude of the Bayer company with regard to the supply of P2o4 to institutes that wish to conduct experiments with it. If a certain quantity of this substance is ordered for the purpose of treating patients, can this firm deliver the necessary amount of this product? Furthermore, does the company guarantee that the product is innocuous or does it accept no responsibility for the planned experiments?

Prof. Antweiler

The Bayer company produces two different batches, one for experiments on animals and the other for the treatment of silicosis in humans. I can give no precise answer to the question of guarantees offered by the company, but I do not believe that such guarantees could be given. The same is true of other pharmaceutical products. There is a certain risk in the use of any substance and P2o4 is no exception to this rule, all the more so in that it is a polymolecular substance whose long-term presence in the human body could eventually always produce certain side effects, although this seems very unlikely as considerable quantities of this substance have already been administered to a large number of subjects.

Dr Vidali

I should like to ask a very simple question which in any case need not be answered conclusively right away. I listened with great interest when Prof. Vigliani told us that infection ultimately plays a decisive rôle in the development of pneumoconiosis. In simple terms, this means that our methods of prevention should aim at reducing dust production at work sites, as well as maintaining a close watch on work places for this and on the pulmonary condition of the workers.

But this also means that a properly designed prevention policy must aim at reducing or eliminating bronchial and pulmonary infection among coal workers. Under these conditions, it is possible to develop this idea in terms of reserach, with a view to finding the best methods of prevention for use by the medical services?

Prof. Voisin

I believe that there are different kinds of problems which may arise in this sphere.

First of all there is the rôle which infection can play in the development of pneumoconiosis. Prof. Vigliani dealt with this just now. It is a very important point which deserves to be studied. There is also another aspect or respiratory infection which does not concern pneumoconiosis but chronic bronchitis. Indeed, it is certain that chronic infection and the attacks of acute infection which mark the course of chronic bronchitis are a very important factor in the aggravation of the effect of pneumoconiosis on respiratory function. This is as a result of the anatomical lesions caused by these infections at the level of the terminal bronchioles and of the pulmonary tissue. It is another aspect of the consequences of infectious episodes and it can only be solved to the extent to which we understand the causes for the particular sensibility of sufferers from chronic bronchitis to bacterial infection. A great deal of the research carried out in the course of the last programme was along this lines, and it is greatly to be desired, as Dr Vidali said just now, that research is actively pursued in this field. We are indeed at present on the verge of reaching some very interesting practical conclusions on the prevention of disease.

Dr Mastromatteo

I should like to ask a question about the use of sputum examination for the early detection of silicosis. Is any work being done in this field?

Prof. Voisin

We are carrying out an intensive programme of work on the problems of sputum examination with particular regard to its biochemistry at the Institut des Protéines and at the Institut Pasteur in Lille. Until now it has only been basic research which has not been developed at a practical level. As far as I know, there is no work being carried out at the moment with a view to verifying if the anomalies detected in the course of the basic research could be put to practical use for the detection of the disease. But it is certainly an interesting suggestion.

Dr Minette

Mr President, in the course of the discussion speakers have frequently emphasised the decisive rôle played by infection in the development of pneumoconiosis. Mr Voisin has just made a very relevant point in reminding us that a distinction must be made in this regard between pneumoconiosis and chronic bronchitis. However, a certain confusion seems still to exist in the minds of some at this meeting. For this reason I think that it should be repeated with some emphasis that the development of an infection during the growth of pneumoconiosis is not a necessary condition for the formation of massive fibrosis. There is no possible doubt that the first and decisive factor in this respect is the inhalation of dust containing free silica. To be sure, infection, particularly tubercular infection may occur causing the appearance of fibrotic masses or aggravating the functional effects of pneumoconiosis. But these are super-added secondary phenomena. On the other hand, one could say that in a certain sense the opposite is true with regard to bronchitis. Here the infectious factors are probably more important than the inhalation of dust, although it is likely that there is some link in this respect.

Prof. Vigliani

It is certain that silicosis is caused by the inhalation of dust. Silicosis can be caused in animals free of all infection and with lungs free of any germ. I simply wanted to say that when there is infection it can provoke local reaction in the lungs which result in more obvious and more serious forms of silicosis. One example illustrates very well the rôle which immunity factors can play in this respect : Caplan's syndrome, where unusually large nodules develop prematurely in the lungs due to immunity reaction. It is certainly simpler to eliminate the inhalation of dust than to prevent with any certainty infection among non-carriers of pathogenic germs. Nevertheless, it is certainly useful to fight against pulmonary infection, for example with the help of vaccine or other methods which could prevent infectious epidemics. In this regard we can recall the role formerly played by tuberculosis among miners; a role known for more than 6o years but today it occurs less, thanks to the fight against tuberculosis.

2. PHYSIOPATHOLOGY AND STANDARDIZATION

Rapporteur general : Prof. F. LAVENNE (Louvain)
Rapporteurs : Prof. K. VAN DE WOESTIJNE (Louvain)
Dr FRANS (Louvain) Prof. G. WORTH (Moers)

INTRODUCTION

(Prof. F. LAVENNE)

It is interesting to view the results obtained in the field of pathophysiology and standardization during the fourth research programme on industrial medicine in the context of what has previously been achieved and also with regard to the questions still unanswered.

In the first research programme initiated by the ECSC in 1956, cardio-respiratory pathophysiology was given pride of place. The principal aims were to understand how pneumoconiosis led to respiratory insufficiency and cardiac failure, to investigate the link between pneumoconiosis on the one hand and bronchitis and emphysema on the other, and finally to assess the degree of occupational disability caused by these diseases.

The previous fifteen years had seen a considerable increase in the study of cardio-respiratory pathophysiology, especially in the United States with the work of Cournand and Riley in New York, Comroe in Philadelphia, and Fenn, Rahn and Otis

Rochester, N.Y. but also in Europe with, to mention but a few, the work of Christie, Bates and Briscoe in London, Gilson and Hugh-Jones in Cardiff, Rossier in Zurich, Knipping in Cologne, and in a very specific field the work of Tiffeneau in Paris.

A new generation of research workers arose, trained in the United States like Sadoul and Brille, in France like Cara, in Germany like Bolt, Worth and Ulmer, and in Italy like Margaria and Sartorelli. It was felt to be essential to exchange ideas and to set up a real organisation of European cooperation within the context of the Community. The great merit of the European Coal and Steel Community has been to provide for frequent contacts between pathophysiologists of different countries and training. These early contacts, later enlarged to cover the whole of Europe, were the basis for the creation of the European Society of Respiratory Pathophysiology.

The first task of the Community was to establish standards. Professor Cara played an important part in co-ordinating the calculation of theoretical values on the basis of height and age for vital capacity, residual volume and forced expiratory volume per second (FEV). These standards, which are essential if everyone is to speak the same language, continue to form a basis for all the work in this field in the countries of the EEC and elsewhere.

At the same time intense research was being conducted on the pathophysiology of silicosis and pneumoconiosis in coal and iron-ore miners. Between 1960 and 1963 many papers on this subject were published by research workers in Germany (Worth and Ulmer), Italy (Margaria and Sartorelli), France (Sadoul) and Belgium (Brasseur and Petit).

The second research programme began in 1961 and was concentrated more on bronchitis and emphysema than on pneumoconiosis.

The important problem of the relation between exposure to dust and chronic bronchitis gradually dominated attention. Here we must mention in particular the work of Worth and his colleagues. The early workers in this field were joined by Orie and colleagues in Holland and by Van de Woestijne and Minette in Belgium. These newcomers made a considerable contribution to the study of the mechanics of breathing and to the standardization of pharmacodynamic broncho-dilator tests. At the same time a committee of the Working Party on Respiratory Pathophysiology, was preparing a Community questionnaire which would lead to standardization in research work on chronic bronchitis.

The outcome of these undertakings, the results of which were presented at the symposium on bronchitis and emphysema held at Stresa on 21-22 April 1966, was to organise an epidemiological survey on chronic bronchitis,one of the most important themes of the fourth research programme, the results of which are to be presented shortly.

The pathophysiology of pneumoconiosis was again a major aspect of the study in the third programme, and the results concerning cardio-respiratory pathophysiology were presented at the symposium held in Wiesbaden on 2-4 June 197o. New methods had been developed which allowed a more thorough study of pulmonary circulation and of the ventilatory mechanics of disorders in blood gas transfer in the lungs. In the study of pulmonary circulation cardiac microcatheterisation was used to collect the data.

The existing research teams were joined by other researchers, particularly by Denolin in Brussels and Casula in Sardinia, who contributed to the present emphasis on examining cardiopulmonary function during exercise. This is led to the development of another important topic of the fourth programme, the problem of rehabilitation.

During the fourth programme of research the theme of cardiorespiratoy pathophysiology will be developed primarily with a view to determining techniques which can be used in epidemiological investigation. Research initiated during the third programme will also be continued.

The results will be presented later by Professor Van de Woestijne who will speak about the mechanics of breathing, by Dr Frans on the test for carbon monoxide diffusion, and by Dr Worth whose research covers a very wide field.

REPORT BY PROF. VAN DE WOESTIJNE

In recent years a great amount of work has been performed to develop techniques more sensitive than classical spirometry to detect early changes of pulmonary function leading eventually to respiratory insufficiency. Not only should these techniques be more sensitive but they should also lend themselves to field examination. The purpose of the research projects, which I will now present is to develop such techniques.

1) The first two teams of research workers studied methods for the measurement of respiratory restistance. Both are forced oscillation methods.

a) SMIDT, SCHILLING, WORTH and NAKAJAMA from Moers proceeded with the delevopment of the technique they described in 1971 (figure 1)

Vergleichs-Oszillations-Methode zur Bestimmung der Strömungswiderstände 403

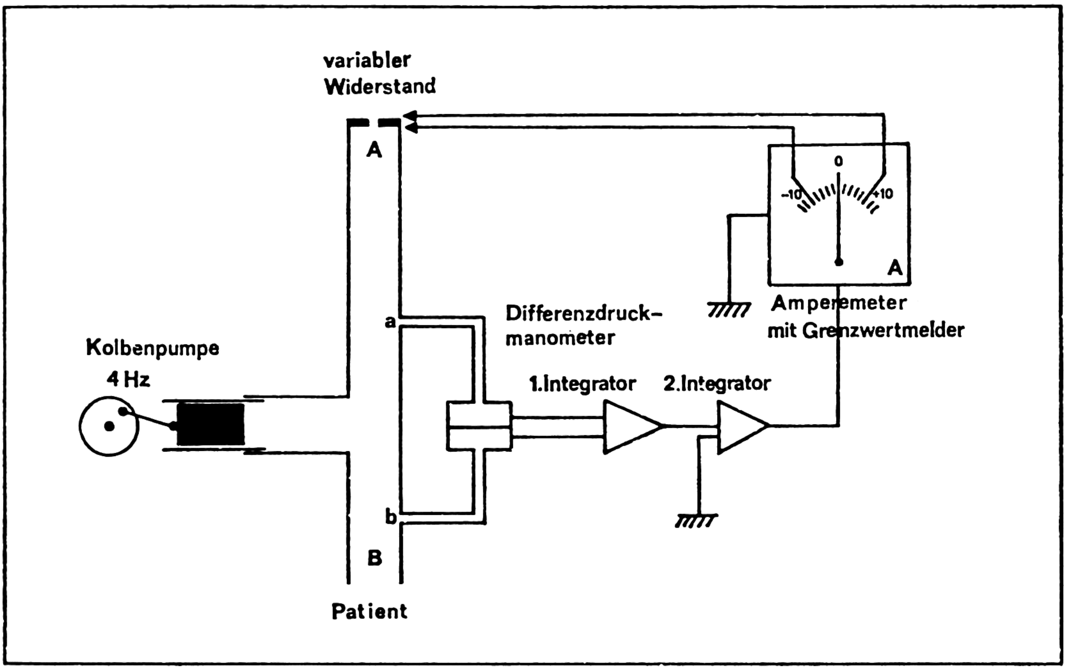


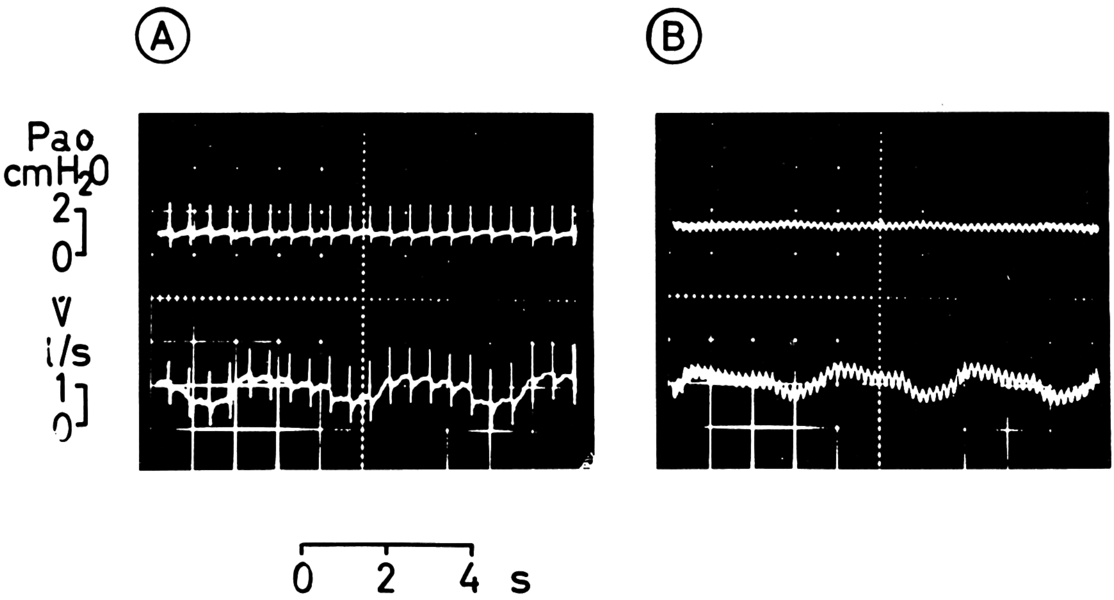
Abb. 1. Prinzip des Gerätes für die Vergleichsoszillation. Siehe Text.

In principle, the technique is as follows. Forced oscillations are imposed by a sinusoidal pump on the subject, as he breaths, At the other end of the T tube though which the subject is breathing a resistance is placed, which can be varied until it is equal to the subjects' resistance. In this way, the resistance of the respiratory system is determined very simply using only one transducer and no special recording device.

The authors improved the stability of the oscillatory flows, the aerodynamic symmetry of the T tube, and linearized the flow signals. To compare the measurements of the technique with those obtained by body plethysmography, they developed a computer program yielding on line the "effective" bronchial resistance. This improved to some extent the comparison between both techniques (correlation coefficient r=o.62). Accordingly, the forced oscillation technique appears to be suited for epidemiological studies.

b) The approach of LANDSER, NAGELS, CLEMENT, BILLIET and VAN DE WOESTIJNE from Leuven, was different. In a first stage these investigators studied the sources of error responsible for the variability of the technique. They concluded that, besides the error due to the superposition of the forced oscillation with the slow respiratory frequency of the subject, there is a much more important source of error due to the oscillations of the same frequency as the forced ones, present in the subject's own breathing. The only way of correcting for the high frequency oscillations of respiratory origin is to calculate an average resistance over one or more respiratory cycles. It can be shown that in these conditions an unbiased resistance value is obtained. This preliminary work allowed the authors to develop a new technique, derived from the forced oscillation technique. It consists in submitting the spontaneously breathing subject to Dirac impulses, repeated every o.5 s during 16 s.

The figure 2 shows a comparison between the forced oscillations, similar to those applied classically, with the Dirac impulses. The letter are superimposed on flow and pressure recorded at the mouth. Pressure and flow at the mouth are then analyzed by means of a fast Fourier transform technique. In this way, average resistance and reactance values are obtained for all harmonics of 2 Hz up to 3o Hz. The comparison of the results with those of the forced oscillation technique and with the bronchial resistance measurements obtained plethysmographically is very satisfactory. The reproducibility of the method is good (Coefficient of variation : 12 %).



2) The interruption technique is the other method which has been investigated. PETIT and coworkers from Liege, compared the value of closing volume, measured with Helium as a tracer gas, with the volume at which "asynchronisme ventilatoire" becomes apparent during expiration. "Asynchronisme ventilatoire" is a phenomenon described earlier by PETIT. The spontaneous breathing of the subject is interrupted regularly, once during 1/1oo of a second and, immediately afterwards, during 1/1o of a second. The comparison of the pressure peaks measured at the mouth during the short and long interruptions is an estimation of so called asynchronisme ventilatoire. The correspondence between closure volume at which asynchronisme begins is very good in healthy subjects as in bronchiticts,

as well as between the variations of both volumes, following inhalation of histamine, or orciprenaline. "Asynchronisme ventilatoire" during spontaneous breathing is less sensitive as a test, since it is found only when closing volume exceeds the respiratory level. The authors conclude that the interruption technique yields as much information as closing volume and is even more sensitive than the latter since no previous deep inspiration is required. It is therefore a useful way of detecting incipient bronchial obstruction.

CARBON MONOXIDE TRANSFER FACTORS

(Dr. A. FRANS)

I shall attempt to summarize the main points of the work done by three research groups, those at Toulouse, Nancy and Créhang

The Toulouse and Nancy teams conducted epidemiological researc on various groups, and the measurement of CO transfer factors was only one of the aspects of their work.

There are numerous tests for CO transfer (see Fig. 1), but in practice, the breath-holding and steady-state methods, at rest and during exercise, are those most commonly used (see Fig. 2)

In the breath-holding method (Fig. 3) the DLCO and DLCO/alveolar volume are measured. In the steady-state method the DLCO is related to ventilation or a simpler coefficient is calculated, CO ductance or fractional CO uptake.

I. The group working in Toulouse measured the transfer factor by breath-holding and steady-state methods, and CO ductance.

They divided the 1 ooo subjects examined into three categories :

- those suffering from chronic bronchitis (for between 3 months and 2 years);
- subjects with respiratory symptom, who had not yet reached the stage of chronic bronchitis;
- subjects without symptoms.

Two preliminary remarks need to be made in connection with CO transfer tests by the steady-state method :

1) the transfer factor may be normal when the ratio TLCO/ ventilation and the CO ductance are pathological. This explains why the CO ductance was normal in only 51% of the subjects without symptoms,

2) the PDC CO (pulmonary ductance coeeficient) and TCO/VE (CO transfer/expired volume) are more frequently pathological, than the spirogram,

3) with the breath-holding method the results are normal in 4 out of 5 subjects; this applies both to the TLCO and to the TLCO/TLV (total lung volume) ratio.

In conclusion, it appears that steady-state tests are more sensitive but less specific than breath-holding tests.

II. The research group in Nancy studied workers from the iron and steel and building industries, and inhabitants of the city, at their places of work.

CO transfer was measured by the breath-holding method, by the steady-state method as described by Bates, and by CO ductance; the last two tests were carried out at rest and during activity involving exercise of 4o W.

1) The results are fairly even over the whole of the popu-

lation. The authors therefore examined the results as a function of various criteria, namely age, smoking habits, severity of work, and symptoms.

2) For workers in the building industry aged between 4o and 6o :

   a) Effects of age: the findings of the various steady-state tests, especially CO ductance, decrease with age. This tendency is not noted with breath-holding TLCO;

   b) Effects of symptoms : the subjects were grouped in four categories : those in Group I had no symptoms and those in Group IV were suffering from chronic bronchitis.

The researchers noted a deterioration in ductance and in the transfer factor in steady-state conditions, measured at rest. However, during exercise these indices and the breath-holding TLCO readings showed no significant correlation with symptoms.

   c) Effects of smoking : the volunteers were divided into four categories, depending on the intensity of their smoking habits; Group I consisted of non-smokers. The CO transfer readings in steady-state tests were significantly lower in smokers than in non-smokers; however, there was no difference between the groups of smokers.

   d) Severity of work : few subjects were employed in heavy work (7/196). The steady-state and breath-holding TLCO were higher in these workers.

3) Iron and steel workers - there are a number of differences between this study and the previous one. It appeared that age, smoking habits and severity of work did not significantly affect the transfer results. However the breath-holding TCO and ductance at rest showed a correlation with symptoms.

One very important fact was that exposure to dust, fumes and vapour was associated by a slight drop in CO ductance during exercise especially in the breath-holding test.

The authors concluded from their studies at the place of work that both spirography and CO tests helped to demonstrate a number of anomalies in subjects who did not have symptoms of coughing or expectoration - 48% of such subjects showed decreased levels in one or other of the tests.

Also, decreased levels in a combination of CO tests and spirography tests were noted in 80% of the subjects with symptoms.

III. The Créhange team's objective was to assess the arterio-alveolar CO_2 and the partial CO_2 pressure in arterial blood <u>without taking blood samples.</u>

Taking as a starting point the fact that the formulae for CO and CO_2 transfer factors are linked by a constant 'C' and bearing in mind the form of these two equations, Dechoux and Pivoteau showed that this constant could be calculated by measuring :

i - TCO and VCO_2 by classical methods
ii- $PaCO_2$ by an electrode applied to arterial blood
iii- $PACO_2$ was calculated by Bohr's equations.

<u>Results</u>

Measurements were carried out on 409 subjects, 31 normal and 378 suffering from asthma, chronic bronchitis and emphysema. The average value of 'C' was 0.42 (SD=0.07).

One 'C', VCO_2 and TCO are known, it is easy to calculate ($PaCO_2$ - $PACO_2$) and $PaCO_2$ indirectly.

The correlation between the direct and indirect $PaCO_2$ values is 0.9.

Comments

1) The scatter of values of 'C' is dependent both on the relative accuracy of the $PaCO_2$ and expired CO and CO_2 values, and on the fact that the dead spaces for CO and CO_2 are not always identical.

2) The correlation observed between the direct and indirect $PaCO_2$ shows that this method may be of value in clinical applications, as it provides a means of detecting hypercapnia and estimating CO_2 gradients without taking blood samples.

3) This method provides further information on the correlation between TCO and hyperventilation. TCO and (a-A)DCO_2 increase with hyperventilation, the former more so than the latter in normal individuals, whereas the opposite occurs in persons suffering from pulmonary disorders.

4) Using a dual system of coordinates, plotting CO_2 excretion vs. transfer factor, the transfer factor and the arterio-alveolar pressure gradient can be corrected for standard ventilatory conditions.

DL_{CO}

- SINGLE - BREATH METHOD	Krogh 1915 ; Forster	1954
- STEADY STATE METHODS		
PACO : END TIDAL SAMPLING	Bates	1952
PACO : CALCULATED BY EQUATION	Filley	1954
PACO : COMPUTED FROM AN ASSUMED VD	Williams - Zohman	1958
PACO : COMPUTED FROM ESTIMATE OF MIXED VENOUS PCO_2	Marshall	1958
STEADY STATE CO UPTAKE DURING REBREATHING OF CO	Lewis	1959
STEADY STATE CO UPTAKE AND ANALYSIS OF CO-HE CLEARANCE	Mittman	1967
- EQUILIBRATION - WASHOUT TECHNIQUE	Burrows et al	1958 1960

FOR CLINICAL PURPOSES

DL_{CO}	SINGLE BREATH AT REST	
DL_{CO}	ST ST BATES / FILLEY	AT REST / DURING EXERCISE

ARE GENERALLY USED

FOR CLINICAL PURPOSES

DL_{CO} SB at rest

DL_{CO} ST ST <u>Bates</u> / <u>Filley</u> at rest and during exercise

DL_{CO}

DL_{CO}/VA' OR DL_{CO}/VA

$$VA' = IV \times \frac{HE\ insp}{HE\ exp}$$

$$VA = IV + RV$$

DL_{CO}

$DL_{CO}/\dot{V}E$

$DL_{CO}/$ Br. Fr.

"k" of Krogh

$$\frac{\ln\left[FA_{CO_0}/FA_{CO_t}\right]}{t} \times 60$$

F.C.U.

$$\left[\frac{FI_{CO} - FE_{CO}}{FI_{CO}}\right]$$

REPORT ON PROJECTS o42, o43, o47, o49 and o54++ RELATING TO PHYSIOPATHOLOGY AND STANDARDISATION

(Prof. G. WORTH)

The researchers working on projects relating to physiopathology and standardisation have been concerned with the development, testing, assessment and standardisation of new methods of investigation of cardiopulmonary function. The research projects on which I have to report are concerned with the formal analysis of the expiratory partial pressure curves of oxygen, carbon dioxide and helium and with alveolar-arterial gradients, ergometry and the use of computers in the assessment of pulmonary function. Apart from the last two topics, the research is also concerned with the assessment of the respiratory gas exchange, the main function of the lung.

Significant advances have been made in this field in recent years partly as a result of the refinement and simplification of methods of measurement, which allow more extensive application of the techniques and more accurate diagnosis.

Messrs. Maugeri and Serra have reported that development of their battery-driven analyzer for measuring CO_2 and helium in the tidal air is finished. This apparatus permits the concentration curve of these gases in the expired air to be traced throughout one or more expirations. It was shown by Serra and ourselves some years ago that abnormalities in these concentration curves are a very early symptom of local disorders characteristic of the initial stages of most lung diseases. Using this method, which allows He and CO_2 to be recorded, it

++see page 70 for the list of the researchs concerned is possible to detect at an early stage changes that are characteristic of peripheral obstructions. The apparatus that has now been developed is very suitable for screening in industrial medical practice. In hospital investigations it can also be used for measurements in individual bronchi. In addition, it can be used to determine the closing volume and thereby to identify local disease processes. The closing volume is the lung volume that can still be expired after the primary airways have closed in the course of expiration; in the case of small airways diseases in particular this volume increases.

As important as analysis of the form of O_2 and CO_2 expiratory partial pressure curves is the determination of the O_2, CO_2 and N_2 partial pressure differences between arterial blood and alveolar air. Mrs. Brille and Mrs Hatzfeld have been working on this. However, there have been considerable methodological problems and also theoretical discussions as to what actually constitutes alveolar air, with the result that the research has been fully preoccupied with these questions. This research has shown that the dead space cannot be calculated by means of theoretical formulae;it must be determined in each individual case. Only then are the conditions for determining the alveolar gas concentrations fulfilled and at the same time the conditions for determining alveolararterial gradients, a vital step.

Prof. Cara has been working on standard values for ergometric tests with 18-23 year-old men and women subjected to increasing physical exercise; this has been proposed as the uniform type of exercise test for the countries of the European Community.

His conclusion is that pulse rate correlates better with the level of exercise than blood pressure and oxygen intake. However, we shall also have to prepare standard values for older age categories and for parameters relating to the pulmonary as well as the cardiac function.

In Moers we have also been concerned with ergometry, not however from the standardisation aspect but with a view to using it to assist in obtaining a better differentiation of the wide range of causes of dyspnoea of which so many patients complain. Tests with over 3000 steelworkers and miners have shown that even a very detailed function test is frequently not adequate for this purpose. When, however, we compared groups of cardiac and bronchitic patients with a further group of subjects who had no record of cardiac or pulmonary disease but yet complained of dyspnoea on exertion, characteristic differences emerged in the patterns of the abnormal findings. Whereas the cardiac patients tended in particular display a higher pulse rate while the ventilatory parameters remained normal, the bronchitics displayed all the signs of inefficient ventilation : increased respiratory minute volume, higher respiratory equivalent for O_2, distortion of the O_2 and CO_2 expiratory partial pressure curves and a reduced arterial pO_2. Subjects without cardiac or pulmonary diseases, but whose breathing was laboured following exertion, were characterized by metabolic acidosis (i.e. reduced buffer bases, low pH value, compensatory increase in CO_2 output, increased respiratory quotient, reduced arterial and alveolar CO_2 pressure and increased arterial O_2 pressure) and also by increased systolic blood pressure, the latter probably the result of inadequate capillary flow of the muscles and a poor physical condition due to lack exercise.

Assessment of the large numbers of values was only made possible by on-line computer processing. In his research project on the use of computers Mr Valentin also reaches the same conclusion, i.e. that the effectiveness and value of our methods of investigation has been improved in many respects through their use, particularly since they also greatly facilitate comparison with data obtained from previous investigations and the presentation of results. Mr Valentin's team has also been working on the on-line calculation of the differential resistance, using a small analog computer. However the use of this method with 600 cases showed that the time required for the measuring procedure placed too great demands on a considerable proportion of the subjects,particularly the more serious cases.

To conclude, research in the field of physiopathology and standardisation has resulted in obvious overall progress. It has solved a number of problems and simultaneously, as always , raised new questions that we shall have to deal with in the future in the interests of even more simple and more accurate diagnosis.

List of the researchs concerned

042	Prof. MAUGERI Pavia	Study of changes in gas exchange due to distributional disorders
043	Prof. WORTH Moers	Standardisation of studies on the respiratory system and ergometric studies in order to differentiate between pulmonary, cardio-circulatory and metabolic functional disorders.
047	Dr BRILLE Paris	Study of the alveolo-arterial gradients of oxygen, carbon dioxide and nitrogen in cases of obstructive broncho-pneumonopathy.
049	Prof. VALENTIN Erlangen	Standardisation of pulmonary-function tests with the aid of computers
054	Prof. CARA Paris	Standardisation of evaluation methods

CONCLUSIONS

(Prof. F. LAVENNE)

Research in any field is infuenced by the discovery of new methods, by the recognition of new trends, and by the interest of new researchers.

The inclusion of British research teams in the fifth programme which, it is hoped, will commence in January 1976 has led to renewed attention being paid to the early diagnosis of the cardiovascular effects of pneumoconiosis. It is apparant however, that research should be particularly developed along two lines.

On the one hand, standardization of new techniques should allow an earlicr diagnosis of emphysema during epidemiological investigations than was the case when only the method of forced expiratory volume per second was used. There must be standardization in recording the mechanics of breathing, including the flow-volume diagram, the expiratory curves of helium, oxygen and CO_2, and CO transfer. The introduction of a series of simple standardized tests will lead to further improvement in epidemiological research which in any case must continue.

On the other hand cardio-respiatory pathophysiology will lead to a standardization of cardio-respiratory functional rehabilitation. Two aspects of this topic were considered important enough to be selected for preparatory research which will begin as soon as the funds are available.

Firstly, exercise tolerance tests must be standardized. As early as the first and second programmes. particular attention had been paid to the standardization of ergometric appliances, especially bicycles. During the fourth programme a committee of the Working Party on Respiratory Pathophysiology has evolved a graduated exercise tolerance test, indicating the parameters which must be measured every three minutes. It is hoped that a total of 9oo male subjects, aged from 18 to 65, and 63 female subjects, aged from 18 to 5o, will be tested in 6-8 laboratories. As a result of the very precise instructions which have been drawn up, it will be possible to obtain normal exercise standards in workers of different ages in the countries of the Community. If the funds are made available quickly, the investigation can get under way virtually at a day's notice and results can be expected very soon after.

But this research is useful with regard to rehabilitation only if research is carried out at the same time in factories and mines, on the physical effort which various jobs require. The available figures are very incomplete and unfortunately already out-dated. Yet it is well known that technical developments may alter working conditions for the better (by reducing the physical effort required) or for the worse (by increasing noise stress).

The study of cardio-respiratory pathophysiology and standardization must consequently retain a very important position in the fifth programme of research, certainly more than in the fourth, and must concentrate on problems of applied pathophysiology.

DISCUSSION

Dr. Brille

Since I have been a member of the Working Party on Physiopathology and Standardization since 1955 and have worked on standardization as well as on bronchitis and emphysema, I should like to introduce this discussion with a general comment. I have listened with interest to the speeches which have been delivered and would like to draw attention to the following points :

In his conclusion, Mr Lavenne referred to the importance of standardization. In the current situation, where so many new methods are recommended, I cannot help but support his views, for with increasing technical progress and more and more complex measuring devices, we are sometimes deceived into overemphasizing technique and losing sight somewhat of our actual physiological aims. For this reason I should like to remind everyone that in addition to standardization, this working party also has other tasks, namely to acquire a better knowledge both of the basic physiological principles of the diagnostic methods, and of the basic phenomene underlying respiratory diseases and insufficiencies. For 2o years now, we have been concerned with research on lung function. Many patients complain initially of shortness of breath. If they subsequently show symptoms of hypercapnia, that means that their lives are threatened, often, at a relatively early age in the case of chronic bronchitis and pneumoconiosis - diseases which according to our current knowledge depend to a large extent on the nature of place of work.

We must not forget that a basic knowledge of the diseases concerned is indispensable for the development of preventive measures on a sound scientific basis. Such measures, which Dr Vidali also referred to this morning, are constantly in the forefront of our minds. They constitute one of the principal tasks of the Working Party on Physiopathology and Standardisation, in addition to specific aspects of technique and standardisation.Professor Voisin also spoke of basic principles this morning, when he opened the meeting on basic research.

In my view, this poses a problem of terminology and semantics. The Working Party on Basic Research is concerned with cell research and animal experiments. However, the domain of physiology and pathophysiology is also concerned with basic principles - in fact, even more than may have been apparent from the reports we have heard here. We should not lose sight of this in our future work in this working party.

Prof. Lavenne

I can assure you, Miss Brille, that this aspect of physiological research is not neglected by the Research Committee or by the Producers' and Workers' Committee. In the Working Parties on Epidemiology and Rehabilitation, too, where we apply the various methods of study in practice, we need to have well-founded and standardized methods. We have already been concerned with this type of work for eight years and shall continue along these lines.

Dr Vidali

I should like to thank Miss Brille for her comment on the discussion. I too am of the opinion that it is very important to apply simple and reliable procedures when attempting to assess the various physiological functions of the lungs, particularly in relation to people at work. We need such methods for two reasons: firstly, in order to discover injuries caused by the nature of the place of work, and secondly, to assess the degree of stress entailed by the work. In addition to the question of protection from diseases, these questions also require our attention. We need simple methods which can be implemented on the spot at the workplace. Standardisation is relevant not only to epidemiological studies, but also to methods intended for use at the workplace. We must bear this in mind if we wish to improve practical working conditions.

Our undertakings are tending more and more to introduce ergonomic principles. In making plans to remodel workplaces, we require methods which can be used for study purposes at the workplace itself. I believe that industrial physicians can provide the link between theory and practice. An on-going exchange of views is needed here. The doctor and the ergonomist both need simple methods. We urge the researchers to consider this need and to provide better ways of assessing occupational stress. Indeed the contributions to this meeting already provide evidence of endeavours towards this end, which indicates that the hoped for dialogue is already proceeding in the right lines.

3. EPIDEMIOLOGICAL INVESTIGATION

Rapporteur general : Prof. P. SADOUL (Nancy)
Rapporteurs : Prof. U. SMIDT (Moers)
Dr. D. BRILLE (Paris)
Prof. K. VUYLSTEEK (Gent)
Prof. R. VAN DER LENDE (Groningen)
Prof. M. CREPET (Padova)
Prof. R. BOLLINELLI (Toulouse)

INTRODUCTION

(Prof. P. SADOUL)

Included in the ECSC research programme for 1971-1974 were 17 contracts for epidemiological research. Some industrial doctors, producers, workers and government experts were probably surprised that the Research Committee devoted such an extensive place to epidemiology. In the opinion of these sceptics, such research, a priori very costly, would lead to results of very little practical interest. As you may have gathered from the reports on respiratory physiopathology this morning, epidemiologists make great contributions to other branches of research on respiratory diseases. The fact is that a better knowledge of the frequency of clinical and functional anomalies in connection with working conditions is vital, if the harmful which cause bronchopulmonary disease are to be reduced.

Thanks to studies on incidence, sometimes referred to as cross-sectional studies, epidemiology makes it possible to determine which jobs are dangerous, and to combat the most dangerous types of pollution.

Thank to follow-up studies carried out over several years on accurately defined groups, it is possible to identify the risk factors, both professional and extra-professional, as well as the earliest signs of respiratory infection. The industrial doctor therefore has at his disposal during medical examinations not only a valid questionnaire, but also functional examinations which, although simple to apply, do have a satisfactory forecasting value. This early detection is made all the more necessary by the fact that epidemiological surveys have shown that, among subjects still at work but already suffering badly from respiratory insufficiency, less than 10% were under medical supervision. In the case of workers in whom the danger signs are still hardly distinguishable, simple measures of hygiene and often a change of job would avoid the onset of permanent and total invalidism.

The implamentation of these epidemiological surveys has profited greatly from the experience of our British colleagues. It is well-known what an essential contribution British researchers have made to methodology. For this reason, researchers within the Community insisted on discussing their plans for research in Edinburgh, before starting work on them in 1971. However the programme reported on today included no British contracts, and the various rapporteurs will only consider research carried out in continental Europe.

REPORT ON EPIDEMIOLOGICAL RESEARCH ON STEEL WORKERS AND COAL MINERS

RESEARCH PROJECTS o24, o26, o27, o29, o34, o36, o73 ++

(Dr U. SMIDT)

For more than lo years the significance of the inhalation of dust at work as one of the causes of chronic bronchitis and pulmonary emphysema has been of considerable concern to the western industrialized nations, both from the occupational medical and the sociological point of view.

The erstwhile European Coal and Steel Community, nowadays part of the Commission of the European Communities, has in particular supported research dealing with occupational diseases in coal miners and steel workers. Apart from silicosis, chronic bronchtitis and pulmonary emphysema were of prime importance.

It is my task at this point to report on research dealing with the frequency of these illnesses in coal miners and steel workers.

Research into this was undertaken by

Dr Brinkmann in Recklinghausen, Germany
Professor Caccuri in Naples, Italy
Professor Casula in Cagliari, Italy
Dr Deniau in Briey, France
Dr Minette in Lanaken, Belgium

++ See page 82 for a list of the researchs concerned

Professor Sadoul in Nancy, France
Professor Zannini in Genoa, Italy
and by us under Professor Worth in Moers.

The interest of these researchers in the frequency of these diseases is much more than purely statistical, much more than interest in the mere production of figures for health planning. On the contrary, determination of the frequency of these illnesses in persons occupationaly exposed to dust as compared with those not so exposed is intended to clarify the causal significance of this exposure. This requires the very time and labour-consumming method of epidemiological research, because the same diseases can result from other causes such as smoking, and to date we are not able to identify the cause in individual cases. Things are much simpler in the case of silicosis, because silicosis cannot occur without exposure to quartz dust. It is, however, perfectly possible to have chronic bronchitis and pulmonary emphysema without occupational exposure to dust.

As a result of clinical experience the opinion that these diseases are more frequent in persons exposed to dust had in fact gained wide currency, so that a causal relationship could be assumed, but it was not possible for the clinician with his methods of individual diagnosis to convert this suspicion into solid proof. Such a step required epidemiological research, which has to be planned extremely carefully, so that the anticipated higher frequency of these diseases in persons exposed to dust genuinely justifies the conclusion that the exposure is actually the cause of this excessive frequency.

The first step, up to 1966, was for a working party set up by the Commission to produce a 13-page questionnaire containing standardized questions to determine each subject's symptoms, previous diseases, occupational activities and smoking habits, and on which the subject's clinical, X-ray and electrocardiographic details and the result of the lung function test were to be entered. All researchers were then required to make use of this questionnaire, which was translated into the various languages, and to measure at least the vital capacity and FEV_1. The working party also wrote a detailed memorandum on the questionnaire explaining how to use it, laying down the evaluation criteria for the X-ray examination of the lungs and the ecg, and providing the guidelines for the training of the doctors using the questionnaire. (Our English colleagues also carried out an additional test on the extent to which the results are internationally comparable).

I hope that these rather long introductory remarks of mine will have indicated the degree of intensive preparation that is necessary if epidemiological research is to give meaningful results, quite apart from the standardization of the measuring methods, the ascertaining of the relevance of the population sample examined and the usability of the control population.

Not only must these be a guarantee that the persons classified as exposed to dust are or were subject to a significant dust exposure, but also above all that the non-exposed control subjects are not at present and were not in the past exposed to dust, but are otherwise comparable, in particular are of the same age and have the same smoking habits.

Both groups must live in the same area, must have as similar physical characteristics as possible, must live in identical socio-economic situations and be examined by the same researcher at the same time of year using the same methods. If I were to take these requirements any further, it would soon be impossible to meet them, but to the extent quoted they were largely fulfilled. The seven researchers referred to above achieved basically the same results, which is by no means a foregone conclusion in the case of scientists.

All the research showed that the criteria for chronic bronchitis (and pulmonary emphysema) are relevantly more frequent in persons occupationally exposed to dust than in those not so exposed. I emphasize "relevant", and do not just say "statistically significant", because even an irrelevant difference can be statistically significant if there are a large enough number of cases.

Professor Casula compared 22oo persons from coal and ore mines, Professor Zannini 3oo blast furnace workers and persons not exposed to dust, Dr Minette 33oo workers from two mines and two steel-works, in each case one being in a low-dust and the other in a high-dust area, Dr Brinkmann 15oo miners subject to differing dust exposures, and we ourselves, under Professor Worth, examined 19oo miners and steel workers. Professor Sadoul examined 581 construction and steel workers, Dr Deniau 86o workers from iron ore mines, and Professor Caccuri 184 workers, some of them from blast furnaces.

All the investigations show that the steel workers are affected by chronic bronchitis and pulmonary emphysema more frequently that those persons not exposed to dust, and that the miners are affected even more frequently than the steel workers, even when the miners are not suffering from silicosis. In the case of the steel workers the frequency is between 25 and 5o % higher, in the case of the coal miners 5o - 1oo% higher. You will understand that more precise figures are not possible, since the age and smoking habits of the subjects also play a major role. It is, however, not the case, for example, as Sluis-Cremer earlier maintained in South Africa, that occupational exposure to dust is significant only in the case of smokers, who are already harmed by another noxa. It is far truer to say that the effect of the different noxae are cumulative, so that each of them has to be combatted. Atmospheric pollution in industrial aereas is also significant, but to a much smaller degree than dust exposure and smoking, whose effects are about equal.

These results demonstrate that occupational exposure to dust must be taken into account in all preventive, therapeutic and assessment considerations as a significant causal factor in chronic bronchitis, and in particular in pulmonary emphysema which seems to be encouraged to an even greater degree. All those who consider this statistical result as not practically relevant, despite its statistical significance, might care to consider that in the individual case a condition may be decisive even when it is statistically meaningless, for example when there is too low a number of cases. If we find in a patient who has been occupationally exposed to dust no other apparent cause for his chronic bronchitis or pulmonary emphysema - but not only in such a case - we should include the occupational factor in our considerations, even more so in the case of pulmonary emphysema than in that of chronic bronchitis. The results of this epidemiological research also oblige us to apply all our energies and all the means at our disposal to the only really effective preventive measure - dust control.

<u>List of the researchs concerned</u> :

o24	Prof. WORTH Moers	Epidemiological research to analyse the influence of air pollution, in particular mine dusts, on the genesis of chronic diseases of the respiratory tract.
o26	Prof. CASULA Cagliari	Influence of atmospheric pollution on the genesis and evolution of respiratory insufficiencies.
o27	Dr. ZANNINI Genoa	Atmospheric pollution and chronic respiratory diseases in the iron and steel industry.
o29	Dr. BRINKMANN Recklinghausen	Panel investigations of chronic respiratory insufficiency in miners and workers in other occupations exposed to dust.

o34	Prof. MINETTE Lanaken	Survey in densely populated industrial areas carried out at the places of work and elsewhere.
o36	Prof. SADOUL Nancy	Epidemiology and development of chronic bronchitis in various occupational groups. Incidents and prognostic value of functional abnormalities.
o73	Mr. DENIAU Briey	Gas nuisance produced by blasting and diesel motors in iron mines underground.

RESULTS OF SURVEYS OF VARIOUS GROUPS OF WORKERS OUTSIDE THE COAL AND STEEL INDUSTRIES

(Dr D. BRILLE)

Epidemiological research on workers other than miners and steel workers - apart from its intrinsic interest - should improve our interpretation of research in the coal and steel industries by providing a basis for comparison. In particular it should provide information on the possible role of various pollutants and extend the scientific bases of programmes for preventing occupational respiratory disease.

This was the reasoning for the grants made to the five projects briefly summarized below.

In all these studies, the data on respiratory symptoms and the complete medical history were obtained by means of the "ECSC questionnaire" in a complete or abridged form, or supplemented, particularly in the case of the occupational history. Normal spirography was carried out in all cases and supplemented in four of the studies by other tests of ventilatory mechanics and in four protocols by measurement of CO transfer (projects o21, o22, o32, o36).

Measurement of pollution at the place of work was made in four of the studies (o21, o22, o28, o32) and consisted of complete and analytical measurements of total and respirable dusts and various gaseous pollutants.

The population group studied depended on the aims of the research. In some cases all the workers in one firm were examined, in others samples were obtained by drawing lots or pairing.

The five studies are "cross-sectional".

Three studies are concerned with several types of firms industries occupations and hazards. Two of these conducted by Professor Maugeri and Dr Pezzagno in Pavia (o21) and by Dr Pham in Nancy (o36), include steel works in addition to foundries, chemical works, cement works, building firms, etc. Professor Bollinelli and Dr Rouch in Toulouse (o32) aim to examine 3 ooo subjects representing the 2oo ooo workers in the "Midi-Pyrénées" region obtained by stratification and random selection from all the factories in the region employing more than loo workers. To date about 1 ooo subjects have been examined from an aircraft factory with virtually no pollution, a pottery works where dust levels are fairly high and a chemical works where the air contains high amounts of gaseous by-products, in particular compounds of nitrogen.

These three studies showed that, if allowance is made for sex, age and smoking habits, there is a significant link between respiratory symptoms in particular cough and chronic expectoration (an answer "yes" to question 7 which may be considered to be diagnostic of "chronic bronchitis"), or impaired performance in one or more of the functional tests and exposure to a given pollutant or pollutants in combination and to their concentrations.

This is illustrated by :

- table 1 from the Pavia team which shows that of 2 1o6 subjects exposed to dust, 42% of those exposed to levels higher than the "maximum admissible concentration" set by the American standards (E++) had impaired test results (first line of the table), as against 28% of those exposed to lower doses (E + second line). The exposure considered is an estimate, for each subject, of the total dose of pollutants inhaled during his working life on the basis of environmental analyses, duration of exposure and intensity of work.

- table 2 from the study by Dr Pham in Nancy which shows on the fourth line that the frequency of the association of "chronic cough and expectoration" increases from 1o% in unexposed workers to 21% in building workers, who are primarily exposed to the elements, to 32% in steel workers. These differences are statistically significant (after standardization for age and tobacco consumption. The subjects studied came from three samples drawn at random from male workers, aged from 4o to 59 and living in the same region : highly exposed steelworkers, building workers primarily exposed to the elements and unexposed office workers and tradesmen. Similarly, in the Toulouse study, the symptoms of "chronic bronchitis" are observed in 6, 11 and 12% corresponding to pollution levels in the three firms.

The two other studies are concerned with an unusual hazard or occupation : the exposed subjects were compared with paired control subjects.

The research conducted by Professor Lauwerys in Louvain (o28), in three factories, is concerned with a single risk : cadmium, and forms part of a general toxological study with specific emphasis on remal effects. Its conclusion was that the admissible limit in Belgium should be reduced from 2oo $\mu g/m^3$ to 5o $\mu g/m^3$.

It showed that in the absence of symptoms, there was an correlation between the total level of cadmium exposure (estimated by atmospheric measurements and the blood and urine levels in the subject) and the reduction of spirographic values.

The Marseilles study headed by Professors Laval and Kleisbauer (o22) in two industries refers to one particular occupation : that of arc welder (for which the pollutants Fe, Zn and Mn oxide, etc, were measured).

A study was made, using a simple protocol (forced expiration was recorded on a dry spirometer), of 1 2oo welders and non-welders from which a selected homogeneous group was obtained by random sampling , this making it possible to compare smoking and non-smoking welders and control subjects in age groups of five years. This group of 2oo subjects was submitted to extensive respiratory function tests.

At the present stage of the analysis which covers only 1o4 subjects, the comparison of the average of different functional values has not shown any significant differences between welders and control subjects but has confirmed the classic relationships with age and smoking habits. At this stage no conclusions can be made; the study continues with the aim of demonstrating differences between the respiratory function of welders and control subjects.

It must be pointed out that in all these studies, although exposure to an occupational hazard certainly seems to cause respiratory symptoms (cough, sputum, dyspneoa, wheezing) and changes in lung function causing concern for the future of the worker, these respiratory symptoms and signs are most strongly associated with tobacco consumption. This is not a new finding but efforts must be made to draw practical and useful conclusions from it.

In conclusion, these studies certainly comply with the Commission's aims as stated in the introduction. Two of them, comparing steel workers and other occupational groups, directly interest the European Coal and Steel Community. Moreover all these five projects with their different approaches contribute greatly towards solving the problem of the occupational risk in general and may be applied to the fields of preventive measures and health safeguards for manual workers exposed to pollution in all occupations, including coal and steel workers. Two of them provide data on the dose-response relationship.

On the whole these programmes have required long and difficult preparatory work on the protocol and methods used.

These studies all received financial aid in addition to that from the Commission of the European Communities. The latter has helped to eliminate some of the differences in methodology and improve comparison of studies made in different countries covering various types of population.

Te preceding comments explain that these research projects were not completed during the period covered by the Community subsidy, that they are continuing and that the results are still being analysed.

The results already obtained and the prospective aims certainly comply with the aim of extending the scientific bases of the programme for preventing occupational respiratory disease.

		SPIROMETRY		
		Impaired spirometry	Normal spirometry	TOTAL
Risk factor (occupational exposure)	E + +	384 (41.8 %)	534	918
	E +	337 (28.3 %)	851	1188
	TOTAL	721 (34.2 %)	1385	2106

Chi-squared = 41.09 $P < 0.001$

TABLE No 1

Maugeri and Pezzagno - Pavia
(project 021)

FREQUENCY OF SYMPTOMS IN THE THREE SOCIO-PROFESSIONAL GROUPS

	GROUP I Steel workers (200 subjects)		GROUP II Building workers (196 subjects)		GROUP III Inhabitants (185 subjects)	
Cough 0 Exp. 0	(89) 44.5 %		(100) 51 %		(107) 58 %	xx
Cough + Exp. o	(9) 4.5 %		(17) 8.5 %	x	(4) 2.1 %	
Cough ± Exp. ±	(38) 19 %		(38) 19.5 %	xx	(55) 29.6 %	xx
Cough + Exp. +	(64) 32 %	xx	(41) 21 %	xx	(19) 10.3 %	xxx
Effort Dyspnoea	(43) 21.5 %		(37) 18.9 %		(39) 31 %	

The asteriks after the figures in the third column indicate comparison of the figures in the first and third columns and the asteriks between the columns indicate comparison of these columns.

x $p < 0.05$ xx $p < 0.01$ xxx $p < 0.001$

TABLE No 2

Q.T. Pham - Nancy
(Project 036)

THE LONGITUDINAL EPIDEMIOLOGICAL STUDIES MADE OF CHRONIC NON-SPECIFIC ANOMALIES OF THE RESPIRATORY TRACT

(Prof. K. VUYLSTEEK)

I. Epidemiological research, as understood by the organisers of the longitudinal study, the results of which are summarized here, is designed - to quote J.P. Barker - :

1. to provide the data required for the planning and valuation of health care;
2. to identify the risk factors which can induce disease, and thus make prevention possible;
3. to evaluate the measures taken to control the disease;
4. to determine the exact course of the disease;
5. to catalogue these diseases.

In the epidemiological research reported on here, the authors assumed that the responsible authorities of the Directorate-General for Social Affairs of the EEC, who made it possible, expected answers to a series of questions regarding chronic broncho-pulmonary diseases in the working environment.

It seemed clear to the researchers that the main concern should be to identify the occupational, and other, risk factors involved, with a view to making prevention - both individual and collective - as effective as possible. Longitudinal studies, over a fairly long period, were accordingly necessary, on the one hand of populations thought to be subject to an occupational risk and on the other of population groups not presumed so exposed.

II. An account is given here of three such investigations, those of Brille, Kaufmann and collaborators of Paris, van der Lende and collaborators of Groningen (Netherlands) and Vuylsteek and Bosch of Ghent (Belgium). Each group approached the complex problem of chronic diseases of the respiratory tract from its own specific angle. Collectively they investigated a wide range of questions.

- The Paris researchers were able to check the morbidity and mortality records of 80% of a mixed industrial population examined 10 - 13 years ago, and re-examine a proportion of this population;

- the Dutch authors conducted a longitudinal study over several years of two cohorts of inhabitants, one of an industrial zone with air pollution and the other of a non-polluted rural area;

- for five to seven years the Ghent team followed a highly selected population in an iron and steel processing plant and compared this population with three other population groups employed on entirely different work.

  Each reasearch team used a similar methodology as its basic technique, namely the ECSC questionnaire or its equivalent on chronic lung diseases, and the generally accepted lung function tests for vital capacity and one-second forced expiratory volume.

  Also used as criteria in forming an opinion - but in strict confidence - were the complementary factors of the socio-occupational classification, sick leave taken, notifications of permanent incapacity and death, and medical records generally.

III. A number of the results confirm findings already made in cross-sectional investigations; other are peculiar to the longitudinal studies.

1. General findings

1.1. The function tests and the ECSC questionnaire on respiratory symptoms used each have their own value. Both are reliable, and are certainly complementary, but to a large extent they are also related.

1.2. The results of the function tests employed (VC and FEV) can be influenced temporarily by a brief increase, i.e. of a few days, in air pollution, which can present difficulties of interpretation in the follow-up studies. This is not the case with the respiratory symptoms noted.

1.3. In the working environment studied - an iron and steel plant - the percentage of employees suffering respiratory symptoms lasting for more than three months per year over a five-year period was 3.2.

2. Findings concerning risk factors

2.1. The correlation between cigarette smoking and respiratory symptoms, already established by prevalence studies, is confirmed : three times as many smokers as non-smokers developed anomalies over the five years observed. A fresh discovery made was that, in the group studied, the mortality rate too was linked to smoking habits.

2.2. The extent of the decrease in VC and FEV_1, which occurs in everyone in time, is directly related to the number of cigarettes smoked. Over the five-year period the loss of FEV_1 in the case of non-smokers was 6.3% and in that of heavy smokers 9.2 %.

2.3. The harmful effect on lung function of a heavily dust-polluted working environment (dust density greater than 3o microgram/m^3) is not perceptible over a five-year period, but can clearly be seen in smokers having worked in such an atmosphere for 1o - 2o years, in other words heavy smokers in a heavily air-polluted working environment will suffer a serious loss in lung function after lo years or so.

2.4. The mean FEV_1 was lower in sufferers from chronic expectoration who had died than in those similarly afflicted who were still living lo years after the investigation. In the same way the decrease in spirographic values over the 13-year observation period was apparently more significant in those workers who already had respiratory symptoms before this period.

This would seem to indicate that the results of the spirographic examination, especially those of the FEV_1 could be useful in the prognosis of respiratory disability (as indicated in the questionnaire).

2.5. The chances of survival are conditioned by membership of a specific socio-occupational group.

This fact was already known for the population as a whole, but has now been confirmed over a relatively short observation period of lo years.

IV. Among the data obtained through these investigations, we may note the following as being of direct importance to the industrial doctor.

1. The harmful effect of cigarette smoking on lung function and respiratory disability.

2. The very injurious cumulative effect on lung function of smoking and occupational air pollution.

3. The prognostic value - from the point of view of both morbidity and mortality - of the ECSC questionnaire, particularly as regards chronic expectoration, and of the spirographic examination, especially the FEV_1.

The concurrence of chronic expectoration and a decreased FEV_1 is a highly unfavourable prognostic factor.

4. The differing death and sickness rates in the various socio-occupational groups.

V. Two possible practical implications for the industrial doctor are :

1. For examinations on recruitment and the subsequent periodic check-ups, it would be desirable to make systematic use of the ECSC questionnaire on chronic lung diseases, and arrange for spirographic tests to be performed.

2. Since occupational dust pollution is particularly harmful to workers in the heavy smoker category, the industrial doctor endeavour to have environmental pollution reduced to a minimum in the industry for which he is responsible, and at the same time try to persuade workers to smoke as little as possible.

VI. In conclusion, the researchers who conducted the investigations reported would point out that, although these longitudinal studies have already provided important evidence to prompt the taking of concrete preventive measures, it is essential that the followup studies be continued in order to assemble more, and more precise, data, with a view to taking measures to protect the health of employees in the industries of the Community.

EPIDEMIOLOGY

(Prof. R. VAN DER LENDE)

In the Netherlands we are conducting follow-up studies in random samples from populations of a rural area (Vlagtwedde) and a polluted area (Vlaardingen). These studies are carried out once every three years. In all studies we ask questions about respiratory symptoms with the aid of a standard questionnaire. In the second study i.e. three years after the first one, we also asked questions about absence from work caused by respiratory diseases.

The first slide shows the proportion of men with one or more periods of absence from work in Vlagtwedde, the rural area, and in Vlaardingen, the polluted area. For this presentation we have devided the men in 2 age groups, namely 15-29 and 3o-39 at the first investigation. Clearly, in the polluted area there is more absenteeism, especially in the older groups. Of course it is possible that people in a town are more inclined to stay home from work than people in rural areas do, at least that is generally believed. However, in our opinion such difference in behaviour cannot acount for the great difference in absenteeism between Vlagtwedde and Vlaardingen in the men aged 3o-39, because the difference is much smaller in the men aged 15-29.

In slide II the incidence of one or more periods of absenteeism is presented in people without respiratory symptoms and in people with respiratory symptoms. I would like to make it clear, that the prevalence of respiratory symptoms is based on the data of the first investigation, and that we asked in the second study about the incidence of one or more periods of absenteeism in the past three years, that is, since the first investigation started. I think it is very impressive to see how large the difference in absenteeism is between people with respiratory symptoms and people without respiratory symptoms. One might say that the presence of respiratory symptoms is a distinct risk for absenteeism from work in the future.

Slide III shows that people who are exposed to dust, smoke or irritating gases in their occupations, have more absence from work than people who are not exposed. However the combination of a "dusty job" and living in an air polluted area is the greatest risk for absence of work.

ABSENTEEISM FROM WORK IN MEN IN THE PAST 3 YEARS, CAUSED BY LUNG DISEASE

	VLAGTWEDDE		VLAARDINGEN	
AGE	15 - 29 Nt = 345 %	30 - 39 Nt = 328 %	15 - 29 Nt = 333 %	30 - 39 Nt = 230 %
MEN WITH ONE OR MORE PERIODS OF ABSENTEEISM	4.9	4.6	6.9	12.2

Fig. 1

ABSENTEEISM FROM WORK IN THE NEXT 3 YEARS, IN MEN AGED 15-39 WITHOUT AND WITH RESPIRATORY SYMPTOMS

	VLAGTWEDDE		VLAARDINGEN	
	Nt	ABS.IN %	Nt	ABS.IN %
NO RESP. SYMPTOMS	434	3.0	291	5.2
PERSISTENT COUGH	59	10.2	65	20.0
PERSISTENT PHLEGM	47	14.9	69	26.1
DYSPNOEA GRADE 3	27	11.1	29	24.1
WHEEZE GRADE 3	22	9.1	34	29.4
ASTHMATIC ATTACKS	19	15.8	24	12.5
BRONCHITIS PERIODS	45	15.6	84	20.2

Fig. 2

	VLAGTWEDDE				VLAARDINGEN			
	15-29 YEARS		30-39 YEARS		15-29 YEARS		30-39 YEARS	
	Nt	ABS.IN %	Nt	ABS.IN %	Nt	ABS.IN %	Nt	ABS.IN %
MEN WITH "DUSTY" WORK	131	5.3	108	7.4	102	6.9	106	17.0
MEN WITH "CLEAN" WORK	214	4.7	220	3.2	230	7.0	124	8.1

Fig. 3

(Prof. M. CREPET)

Not yet received report will be published later.

THE RELEVANCE OF NEW FUNCTIONAL TESTS IN EPIDEMIOLOGY

(Prof. R. BOLLINELLI - Prof. Y. ROUCH)

Epidemiology, which was applied by English authors even before 1960 to the study of chronic pulmonary diseases, has yielded conclusive findings, thanks to joint use of the MRC questionnaire and forced expiration tests, on the incidence of this illness, its socio-economic repercussions, the severity of individual cases, the dominant influence of smoking and age, and the prognostic value of obstructive ventilatory disorders as measured by the FEV_1.

This decisive period in the history of respiratory diseases is drawing to a close and new questions now arise :

- Hypersecretion is a symptom of very differing forms of chronic bronchitis, e.g. bronchitis of the main respiratory tract which induces hypersecretion but only slight disablement, and distal bronchitis in which there may be no hypersecretion but in which obstruction of the airways occurs at an early stage and leads to respiratory insufficiency;

- Furthermore, a certain number of subjects who show no symptoms may still have functional tests which are abnormal, thus indicating disorders of the airways;

- Finally, obstructive ventilatory disorders, symbolised by a fall in FEV_1, are indicative of irreversible lesions.

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The first need is for tests sensitive enough to detect airways obstruction at an early stage when the lesions are still reversible. Epidemiologists therefore need new tests which have been perfected in the laboratory by physiopathologists and which they themselves will then have to prove reliable or otherwise by studying the predictive value of abnormalities observed during longitudinal surweys.

The second objective is then to suggest to the industrial medical officer tests which are easily applicable and sufficiently reliable, for the purpose of preventing ilness.

1. CLASSIFICATION OF FUNCTION TESTS FOR THE EARLY DETECTION OF AIRWAYS OBSTRUCTION

In the respiratory tract there is a conducting zone (in which hypersecretion plays the main role and which is investigated, though not exclusively, by FEV_1) and an exchange zone where respiratory function can be impaired, either by ventilatory disturbance (obstruction of the airways and/or alveolar dilation), on by imbalance of the ventilation/perfusion ratio. In view of this, function tests can be divided into three groups :

- those investigating airways obstruction
- those investigating ventilatory disturbance
- those investigating ventilation/perfusion ratios.

Bronchomotor tests and exercise tests should also be included here.

1.1. Tests investigating airways obstruction

Spirometry will remain very much in use for a long time and is used as a reference in most surveys.

The various forced expiration tests, rather than vital capacity, are of greatest use.

In her longitudinal study D. Brille examining the respective significance of vital capacity, FEV_1 and the FEV_1/VC relationship, has shown that the FEV_1/VC relationship is a better functional indicator than FEV_1 in the detection of obstructive ventilatory disturbance, since it is attered at an earlier stage and is moreover statistically linked not only with bronchial hypersecretion, but also with smoking. On the other hand, if mortality is studied, the FEV_1 has the greater prognostic value.

Other forced expiration tests are used. The peak-flow, the true maximal flow, and FEV o.75, do not seem to be very useful. On the other hand, for the great majority of authors, the most sensitive forced expiration test is the MMEFR (mid-maximal expiratory flow rate, i.e. the maximum expiratory flow 25/75).

Flow-volume curves do not show expiratory flow in terms of time, but of the volume exhaled. This test has been used in a certain number of surveys by Pham, Laval and Kleisbauer, Lauwerys and others.Laval and Kleisbauer showed that there was a progressive diminution of the flow measured at 6o% of vital capacity, as a result of smoking.

Methods of measuring pulmonary mechanics, airways resistance and dynamic compliance were dealt with in the studies of Smidt, Maugeri and Pezzagno who applied body plethysmography within the actual industrial premises. These tests were also used in Crepet's study of more than 1,ooo children of school age from Venice and neighbouring localities.

1.2. Tests for the study of abnormalities of distribution.

The lungs are inhomogeneous and disturbance of ventilatory distribution is probably the first to occur. Tests likely to identify this include:

- the regional study of ventilation by radioactive tracers, in particular Xenon 133, which cannot be used in epidemiology since the gas is radioactive,
- the closing volume, which can be measured using either a radioactive bolus or non-radioactive gases such as nitrogen or helium.

The second test has been studied a great deal in North America, particularly in Canada by Emily Millic, Macklem and others, and has been applied on a large scale in epidemiology by Sonia Buist; these authors consider it to be the most sensitive test, well correlated with MMEFR and with dynamic compliance. Opinions are, however, divided; although the notion of closing volume is theoretically important, from a practical viewpoint it appears that measurements are sometimes difficult to reproduce, that variations with age are great, and that it is sometimes difficult to determine closing volume on the tracings, even if the subjects are only slightly affected. Such is the opinion of Sadoul who has conducted an survey on a group of medical students.

1.3. Respiratory exchange tests

These do not directly investigate the small airways, but provide information on the quality of respiratory gas exchange, whose efficiency depends on ventilation, i.e. renewing of the alveolar gas, on perfusion, i.e. blood volume, capillary pressure, capillary flow, haematocrit, amount and quality of haemoglobin, and on <u>diffusion</u> through the air-blood barrier.

Ventilation/perfusion ratios can be studied by the transfer of CO, either in a single inspiration, or by a steady state method.

These methods were used in particular in the two epidemiological surveys conducted at Nancy by Pham and at Toulouse by Y. Rouch.

The results were analysed in the report of the Working Party on Physiopathology and Standardization and we shall not refer to them here. The following facts emerge, however:

- the results of these tests show increasing degrees of abnormality depending on whether the subjects tested have no symptoms, respiratory symptoms, or are bronchitics;
- a high number (48%) of subjects without no symptoms present functional abnormalities, either in spirography, or above all in CO transfer, or in both these measurements;
- changes in CO transfer and spirography are not strictly parallel; this shows the advantage of combining these two tests for purposes of early detection.

However, as regards the transfer of CO in steady state methods, the limits of normal values are still not known precisely and must be defined more exactly.

Ventilation/perfusion ratios can also be studied by analysing the exhalation curves for oxygen, CO_2, helium or CO.

Finally, determination of the alveolo-arterial gradient is far more sensitive than gasometric analysis which is known to be disturbed at a very late stage.

1.4. <u>Bronchoconstrictor tests</u>

The study of the sensitivity of the bronchi to certain pharmacodynamic substances, in particular acetylcholine, is theoretically of great value. The usefulness of these tests in epidemiology was the subject of a seminar at Lanaken and quite recently Minette presented the results of a survey on groups of miners with chronic bronchitis matched according to age, spirographic values, and smoking habits. He was able to show that sensitivity to acetylcholine beyond a certain threshold in the region of 25% has an unfavourable prognostic value. On the other hand, when sensitivity to these tests is relatively moderate and lies below this threshold, repetition of the tests over a period of several years gives considerable variations, this reducing their reliability.

1.5. Exercise tests

Exercise tests are theoretically very relevant, particularly in industrial medicine, since they enable the respiratory and circulatory behaviour of a subject to be studied at a determined work load. They are, however, difficult to conduct in epidemiology, for they are costly as regards staff, time and materials. They certainly have a great future ahead of them.

2. THE CHOICE OF TESTS IN EPIDEMIOLOGY

All these tests, whatever their relevance, are not equally applicable in epidemiology. In a recent work, D. Brille defined the criteria for their applicability.

They must be reliable, reproducible, easy to conduct, unobjectionable and acceptable to subjects who are not patients but have volunteered to participate in medical research which they perceive to be of value generally, although they will not draw any immediate benefit from it personally.

The tests must also be sensitive and specific.

Higgins defines sensitivity as the ability of a test to identify persons truly affected by a disease, and specificity as the same test's ability to recognize individuals who are entirely free of the disease. The ideal test would be abnormal in all pathological conditions and remain normal in the case of healthy subjects. Thus there would be no false or positive results.

An important problem of standardization therefore exists which is being dealt with by the Working Party on Physiopathology and Standardization.

The cost of each test in time,money and staff must also be taken into account.

Above all, however, test must be chosen in relation to the objectives pursued; for example, one would use different tests when studying the incidence of chronic bronchitis in a given population in contrast to those for longitudinal survey in order to assess the predictive value of certain functional abnormalities, independently of any clinical symptoms.

On this basis, the following tests could probably be applied in epidemiology for purposes of early diagnosis :

- Firstly, spirography, measuring the FEV_1/VC ratio and MMEFR, and the two methods for measuring CO transfer, viz. transfer in a steady state and CO transfer in a single inspiration;

- secondly, the closing volume, the alveolo-arterial gradients and the exhalation curves for elimination of oxygen and CO_2.

Finally, measurements of pulmonary mechanics and exercise tests are certainly of great relevance and should be used in epidemiology, but the complexity of the equipment needed makes them difficult to apply.

CONCLUSIONS

Prophylaxis is the main aim of the EEC's epidemiological research programme. This is exercised on two levels :

- primary prophylaxis which aims to eliminate occupational risks;
- secondary prophylaxis which aims in particular to perfect methods of early diagnosis.

In chronic respiratory pathology, early detection of airways obstruction when this is still reversible necessitates the use of new methods.

Current research has shown :

1. The validity of tests used, in particular pulmonary mechanics and CO transfer tests; determination of closing volume appears to us to be a very useful test in itself, but it is too early to assess its value for epidemiological purposes;
2. The possibility of detecting functional abnormalities in subjects with no secretion and without respiratory symptoms;

3. The value of combining several tests for purposes of early detection, for example spirography and CO transfer;

4. The vital importance of cooperation between the physio-pathology laboratories where the techniques are worked out, and the industrial medical officers responsible for their application;

5. The absolute necessity of continuing epidemiological research in respiratory pathology; in particular, subjects without symptoms but with functional abnormalities constitue a high-risk group which should be studied by means of longitudinal surveys.

The industrial medical officer must be increasingly involved in the prevention of chronic respiratory ailments, and he must thus be able to use reliable and readily acceptable tests whereby disorders can be detected at an early stage.

CONCLUSIONS

(Prof. P. SADOUL)

Whereas the nature and mechanisms of functional impairments may be analysed by respiratory physiopathology, epidemiology must be used to define the frequency and extent of abnormalities in workers.

As a large number of subjects need to be examined, simple methods must be used. However, methods and techniques leading to inaccurate information must not be resorted to in the interests of simplicity. The epidemiological tools must be absolutely reliable.

One tool which is of undeniable value is the questionnaire proposed by the Medical Research Council twenty years ago, which has since been amended by experts from the Community. When used by carefully trained investigators, it gives accurate data on past history and symptomatology. It should be used more frequently by industrial medical officer, at least in its abbreviated form.

Criticism has been directed against spirography by respiratory physiologists, but, despite the difficulties involved, which are often underestimated, this technique provides extremely reliable data. The maximum respiratory volume per second (MEVS) or forced expiratory volume per minute (FEVM) are for detecting obstructive syndromes. There is no doubt that the flow/volume curves and in particular maximum flow of 50% vital capacity provide information more rapidly.

These curves may be readily obtained in industrial medicine as can the mean expiratory flow between 25% and 75% of the vital capacity (MMEFR). Certain authors consider that this gives results which are comparable to those produced by maximum flow at 5o% vital capacity.
However, in addition to these ventilation tests, tests capable of determining the air distribution in the lung and respiratory gas exchanges should be carried out. These may take the form of carbon monoxide transfer tests, for which simple techniques are now available to industrial medical officers. Using either the steady state or single breath technique, industrial medical officers may assess whether gas exchange is still satisfactory without having to analyse the arterial blood gases.

Finally we should stress that standard limits of normality for the functional tests cannot be established without the collaboration of epidemiologists. If the normal values adopted are set too high, there would be an excessive number of abnormal subjects.

In order to make an accurate assessment of the usefulness and predictive value of the data obtained from investigations on respiratory function, epidemiologists must follow up periodically the groups of workers already examined. Only by means of longitudinal studies of this kind will it be possible to improve the tools which the epidemiologists are able to supply to industrial doctors.

Surveys conducted

Over lo ooo workers from the coal and steel industries were subjected to detailed examination of respiratory function during the epidemiological surveys subsidized by the ECSC. It appears that 25% to 3o% of those working in the iron and steel industry suffer from chronic respiratory disorders. The proportion is higher in coal miners, who suffer from dyspnoea more frequently than to steel workers. It is interesting to note that miners are more exposed to dust than steel workers, although the pollution peaks resulting from sulphur oxides are sometimes very high in the steel industry.

The epidemiological surveys have shown that persons suffering from occasional bouts of coughing often becames chronic bronchities five years later (over 2o%). This clearly shows the usefulness of the questionnaire and to some extent the predictive value of the information that it provides. A drop in maximum expiratory volume per second must take even a symptomatic subjects liable to a deterioration in their respiratory condition in the years to come. This deterioration is observed far more frequently when workers are subjected to repeated pollution.

However useful and valuable the various methods of investigation that the factory doctor may know from the epidemiologist he must not think that he will be able to detect all the early signs of respiratory disease. If there is disagreement between the data from the questionnaire or those from the industrial doctor's files and the results of simple functional tests, there is no reason to assume that an error has occurred, that the exploratory methods used have been inadequate or that symptoms have been simulated by the worker. The more complex tests conducted by physiopathologists have often provided an explenation of such disparities.

In conclusion, the works doctor can certainly draw useful conclusions for his day-to-day practice from the information provided by the epidemiologists. Thanks to the latter, for some lo years now, he has had a better understanding of the risk factors and knows more about the harmful effects of smoking. He must therefore draw practical conclusions from this knowledge. He must also use simple methods of functional exploration enabling him to supplement clinical data and information from the questionnaire with certain further vital details.

DISCUSSION

Dr Grieco

Our epidemiological experience is based on two parallel surveys, one in a foundry and the other in a steelworks, covering 1 ooo workers in all. So far the findings on environmental factors, and especially the importance of dust in the pathogenesis of bronchitis, agree entirely with all that our colleagues have said today in the discussion. The inhalation of dust of various compositions is without doubt a major factor in the pathogenesis of chronic bronchitis. However, with particular reference to the situation in foundries and in the iron and steel industry, I feel that the speakers we have heard this afternoon have neglected an extremely important factor in the causation of chronic bronchitis, and that is the frequent cooling of workers because of exposure to irregular thermal variations in many parts of their working premises. Indeed, our experience has shown that there are in fact very many cases of chronic bronchitis among workers who are not exposed to dust. Given this fact, the only possible explanation is exposure to the temperature fluctuations I have just mentioned. We feel, then, that it is important that any survey of the incidence of chronic bronchitis in foundries and steelworks should include measurements of microclimate conditions.

Prof. Sadoul

I should like to thank Dr Grieco for his interesting comment. Briefly, I should like to reply that we too were struck by these large variations in temperature. For this reason, we used building workers as a control group in Nancy, as these workers are subjected to less extreme, although by no means negligible, fluctuations in temperatures at work. I think that another group we might well study in future research would be persons working in the refrigerating areas at slaughter houses. Such workers are very often exposed to sudden changes in temperature when fetching meat and animal products from the refrigerators and taking them outside, and it would be interesting to use them as a control group, in order to distinguish between the effects of pollution and those of extreme changes in temperature.

Prof. Woitowitz

I should like to ask a question in connection with Mr Smidt's paper.

It was very interesting to hear that dust is considered to be one of the main determining factors for chronic bronchitis and emphysema in miners and metallurgical workers, and that this has been proved at international level. It is possible, with the data that have been collected so far, to make conclusive statements about the order of importance of the three major causes of this disease - that is, tobacco smoke, dust and age?

Dr. Smidt

This is an important point which has concerned us for a long time now. The basic difficulty is that such statements must be based on comparisons between variables that are not in fact comparable. This is true above all of age. It might be possible to decide on the relative importance of dust and smoke, and I said so in my report, in a general manner, and I pointed out that according to our research findings, these factors were of roughly equal significance. In other words, a lot of dust is the same as a lot of tobacco smoke, and a moderate quantity of dust is like moderate smoking. But it would be impossible to include age in this kind of 'order of importance' because it is not a risk factor as such.

Prof. Woitowitz

Having heard your reply, I must ask another question. A you know, epidemiological studies of 13 ooo workes in widely varying sectors of industry in the Federal Republic of Germany have shown that in that country, smoking can be considered as the most important factor causing chronic bronchitis. On the other hand, research at international level puts dust in the first place. I should like to know how this can be, and if you can explain why these findings are different from the research results in our country.

Dr. Smidt

The research I mentioned did not indicate that dust was of greater importance, but that dust and smoking were equal. The difference between these findings and the results obtained in Germany could be due to the fact that the groups I spoke about today were less exposed to dust than the subjects in our German studies, where we always took control groups from the same concern. Consequently, there is no control group with zero dust exposure. However, I must admit that this makes comparisons rather less reliable as far as all the other factors are concerned, which must be kept at a comparable level.

Dr Mastromatteo

In the coal and steel industries in the United States, frequent lung cancer has been observed in coke furnace workers. What do other members think about this?

Prof. Sadoul

In iron-ore workers in Lorraine, certainly, the frequency of bronchial cancer is higher than in the population as a whole, although these particular miners work in undergroundmines where there is very little silica. On the other hand, as far as I know, studies of coal miners have not as yet shown significantly higher frequencies of bronchial cancer.

Prof. Symanski

I know that in France all the discussions about lung cancer in iron-ore miners in Lorraine have emphasised the fact that the workers are allowed to smoke underground and do in fact smoke heavily. This could be one of the aetiological factors for the higher frequency of bronchial cancer in this group of workers. This is why no definitive conclusions have yet been reached on the subject. Mr. Sadoul, I have another question to ask you. We all know that you have a great deal of experience in the functional diagnosis of pulmonary disease. Could you tell us whether any research has yet confirmed that there is a correlation between the severity of the pneumoconiosis shown in X-rays and that of the associated functional disturbances?

Prof. Sadoul

All the results published so far show that there is no such correlation. Just yesterday, in one of the workshops, I described a case of second-stage silicosis that was not accompanied by obstructive symptoms nor by deterioration of respiratory gas exchange, but with high arterial blood pressure in the area of the lungs, linked with undoubted restriction of the pulmonary vascular bed. It would be quite wrong to deduce anything whatsoever from X-rays in cases of pneumoconiosis. The most one can say is that serious functional abnormalities are very often observed with serious silicosis, but there is no close correlation of the factors.

Dr. Stanescu

I was rather surprised by Mr Bollinelli's remark on the usefulness of exercise tests in general for the early detection of obstruction of the small airways accompanying early chronic bronchities. I know that Mr Bollinelli made this remark in connection with Mr Pham's work. Altough we are short of time I should still like to have some information on this topic if possible. In my opinion Mr Bollinelli's conclusion here is slightly off the mark.

Prof. Bollinelli

You must have misunderstodd me, Mr Stanescu. I am all for exercise tests, which I think are absolutely essential for diagnosis in occupation medicine. All I said was that it is difficult to apply them in the course of epidemiological surveys at the place of work, because they are time-consuming and may take employees away from their work for too long.

Prof. Sadoul

I should like to thank everyone who has taken part in this discussion, but we must bring it to a close now. My sincere thanks to all the rapporteurs, who had a particularly difficult task in view of the number and diversity of the epidemiological research projects carried out under the present programme. I should also like to apologise to the audience for the fact that the list of speakers given in the programme had since been amended. This proved necessary after the programmes were printed because of the difficulties encountered in dividing up the numerous and sometimes complex reseach projects in the 'Epidemiology' section.

4. THERAPEUTICS - PROPHYLAXIS

Rapporteur general : Prof. E. FRITZE, Bochum
Rapporteurs : Prof. N.M.G. ORIE, Groningen
Prof. W.T. ULMER, Bochum

INTRODUCTION

(Prof. E. FRITZE)

We are rather behind time and we will try to catch up with our schedule. Under the heading of Therapeutics and Prophylaxis, you will naturally be expecting to hear of research findings with practical applications and results, and fortunately this is the case with several of the projects presented here. After all, the aim of all our research is the prevention and treatment of chronic respiratory diseases, caused by the patient's working conditions and other factors. The work on Therapeutics and Prophylaxis described here is concerned not with the prevention or treatment of silicosis - we talked about that this morning - but with the disease that often accompanies pneumoconiosis, chronic bronchitis, which has already been so much discussed here today. It is clear that silicosis or the inhalation of dust are not the sole or the immediate causes of bronchitis - in actual fact there are, as several speakers have pointed out, many causes and usually a whole complex of causes. Moreover there are, of course, individual factors and individual pathogenic mechanisms involved in the various forms of bronchitis, which can be inflammatory and exudative, broncho-constrictive and obstructive, or allergic. The exogenous causes of bronchitis may be occupational, related to certain chemicals, or also non-occupational, such factors as smoking, infection, living conditions, climate and so on. We must understand the significance and relative importance of all these factors if we are to devise effective methods of treatment and prevention. The research projects have studied the various possibilities for prophylaxis and therapeutics from three different angles, and these we will describe to you now. They are :

1. The individual reactivity of the bronchial system, and the significance of the body's own defence systems against bacterial and virus infections;

Mr Orie will read a paper on this subject.

2. The pathophysiological background to obstructive bronchitis and the therapeutic efficiency of drugs in the treatment of bronchial obstruction.

This will be discussed by Dr Ulmer.

3. The research under this heading also dealt with the effects of vapours and dust on the immunological defence system of the airways, and, finally, with the prevention of tuberculosis in miners and the treatment of the terminal stages of chronic bronchitis.

I shall read a paper on this subject at the end of the session.

This research was carried out by the following groups, and I shall mention only the principal names - Messrs Orie, Voisin, Vigliani, Minette, Caccuri, Ulmer and Pernis, and our own research team. I will now ask Mr Orie to speak on the first aspect.

THE REACTIVITY IN PROPHYLAXIS AND THERAPEUTICS

(Prof. N.M.G. ORIE)

Bronchitis is a common complication of pneumoconiosis; its pathology is complex and its causes unknown.

Its principal feature is hypersensitivy of the airways leading to excessive - and abnormal - mucus secretion and bronchial obstruction. The clinical expression of these reactions is coughing and dyspnoea. The irritants that cause these reactions are of various types.

Non-allergic physical and chemical irritants are particularly important in industrial areas. It is important to be able to measure this non-specific sensitivy.

This can be done by conducting a provocation test with an irritant and determining its effect on lung function, by measuring the VC or FEV_1, for example.

Provocation tests with different substances and at different concentrations are, however, time-consuming and sometimes difficult to conduct.

However, this sensitivity is often a function of histamine or acetylcholine sensitivity which is much easier to assess.

Formerly this was measured after a single intravenous injection (Curry); and subsequently by injection of increasing amounts (Tiffeneau, de Vries).

This approach is very important from the practical point of view for various reasons.

It enables us to predict humans reactions with reasonable accuracy, even for irritants which are difficult to use in the laboratory.

It thus makes it possible to practice selective guidance of workers in accordance with their sensitivity and to assess the suitability of a particular worker for a particular job.

It enables us to assess individual sensitivity, which is a very important factor.

Dr Minette has shown that there was a positive correlation between sensitivity tests and lung function in a group of workers.

Thirdly, it makes it possible to quantify in a fairly simple manner the therapeutic efficacy of different types of drugs in combating various irritants. In these cases, an additional test with the irritant itself is often necessary.

The results are sometimes surprising, especially for SO_2.

Finally, it improves our knowledge of the basic processes involved in the origin and development of chronic bronchitis.

This is particularly true if the research extends to the development of this hypersensitivity (Booij-Crie, van der Lende). This also applies to the study of the interaction between, for example, infection (de Vries), allergic reactions (Gökemeyer), proteolytic substances (Ulmer, Islam) and this sensitivity.

Therapy and prevention

As regards bacterial bronchial infection - a frequent and probably very important complication of chronic bronchitis -

a most interesting and promising fundamental piece of research has been conducted by a team in Lille and was described by Drs Degand and Voisin during the reports on basic research.

The practical aspects studied in this project were of two types :

- is either the humoral or cellular defence mechanism of patients suffering from chronic bronchitis impaired? In the vast majority of patients, no immunological insufficiency of this type was found.
- what is the value of bacterial vaccination?

Subjects suffering from chronic bronchitis were divided into two groups. Two of the groups were vaccinated using two different antimicrobial vaccines and the third received a placebo. All the subjects also received an influenza vaccine. In these groups of patients, where the disease had reached a fairly advanced stage, no protective effect could be demonstrated.

Although this result was not altogether unexpected, because of the severity of the cases and the complexity of the problem, the investigators thought that it might be worthwhile to repeat the experiment with less advanced cases.

The prevention and therapy of bacterial bronchial infections therefore remain unchanged :

- vaccination against the viral infections which are often the origin of bacterial inflammation (Stuart Harris)
- prevention and therapy of the obstruction of the airways that often leads to bacterial infection (Löwenberg)
- preventive measures against smoking and biological and industrial air pollution
- early treatment with antibiotics and corticosteroids once bacterial bronchial infection is diagnosed.

BRONCHODILATORS

(Prof. W.T. ULMER)

This report gives me a welcome opportunity of telling you about research that has not only considerably extended our theoretical knowledge in the last few years but has also already been applied in practice, and which already helps patients suffering from certain bronchial diseases to lead a considerably easier life.

These complaints are the most common cause of premature disability (Kinkel (1963), Ulmer and Reif (1966)). According to our mass examinations of the population in the Ruhr and in country districts, about 1o% of people over 5o have certain symptoms of this sort of disease, and 2-3% of this section of the population require treatment (Ulmer et al (197o)). Also with many important occupational diseases these symptoms are a fundamental complication that decides the patients' fate and well-being. This is true for many forms of pneumoconiosis, in particular for miners' anthracosilicosis (Ulmer and Holting (1975)) but also for allergic forms such as bakers' asthma.

With these disease the bronchi become too narrow. An important factor, and sometimes the only factor in this, is the contraction of the muscles surrounding the bronchi. In everyday clinical language these diseases are also termed bronchial asthma, asthmatic bronchitis, asthmatic emphysema or simply emphysema. In view of the bronchoconstriction common to the various forms, these diseases are today grouped together as obstructive airways diseases (Ulmer et al (1966)).

This grouping corresponds to the chronic obstructive lung disease (Cold) of the Anglo-American literature.

It is thus not surprising that a number of research teams have given close study to methods of treating this disease.

It is also gratifying that the four research teams of Professor Caccuri (Naples), Dr Minette (Lanaken), Professor Vigliani (Milan), Professor Ulmer and Professor Iravani (Bochum) have obtained similar results.

These research projects made it possible to experiment with drugs which were still unknown when the research was begun. Our knowledge of many other preparations at the beginning of the research was only very slight. We knew that they were effective but we did not know how effective they were and how long the effect lasted; nor did we know whether combinations of different preparations were better than individual drugs on their own. To the majority of these questions we can now give a definitive answer as a result of this research. A great number of the drugs that were scientifically investigated in this way are now available to patients with obstructive airways diseases.

Many of these drugs were used both as tablets and as aerosols. We thus had to test what differences there were between the various forms of presentation. The dose response curve for orciprenaline (Alupent(R)) in tablet form is given here as an example.

The results for tablets show that a marked effect is achieved 3o-45 minutes after taking the tablet. Maximum effect is reached after two hours. After that the effect decreases again to approach the initial level after 6 hours. The dose response curve shows that just a quarter of a tablet (o.oo5g) achieves over 5o% and half a tablet over 8o% of the effect of a whole tablet. A higher dose of more than one tablet

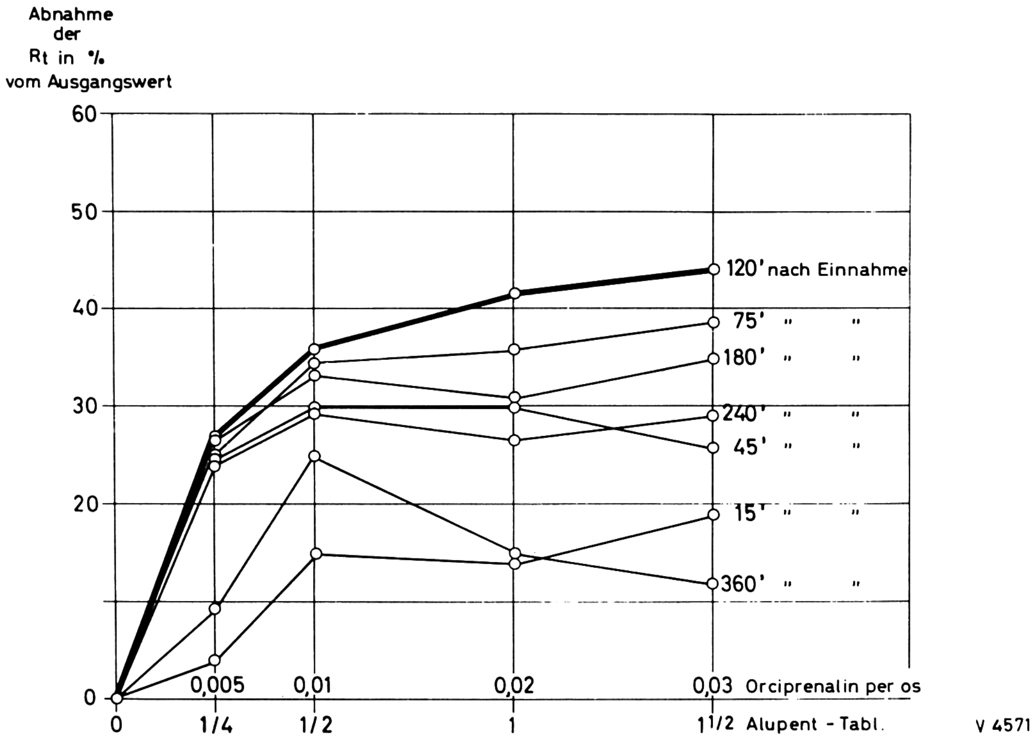


Figure 1 : Dose response curve for effect of orciprenaline tablets on airways resistance at various times after taking the tablet (according to Baving and Ulmer (1970)).

does not bring any further improvement in the desired effect, nor can the effect be prolonged in this way. With these higher doses, however, there is an increase in the frequency of the undesirable side effects peculiar to this group of drugs in the catecholamine series. The patients have palpitations, a quickened pulse and become agitated.

The next diagram (Figure 2) shows this even more clearly. Repetition of the oral doses of orciprenaline (Alupent $^{(R)}$) leads to no further improvement in airways resistance.

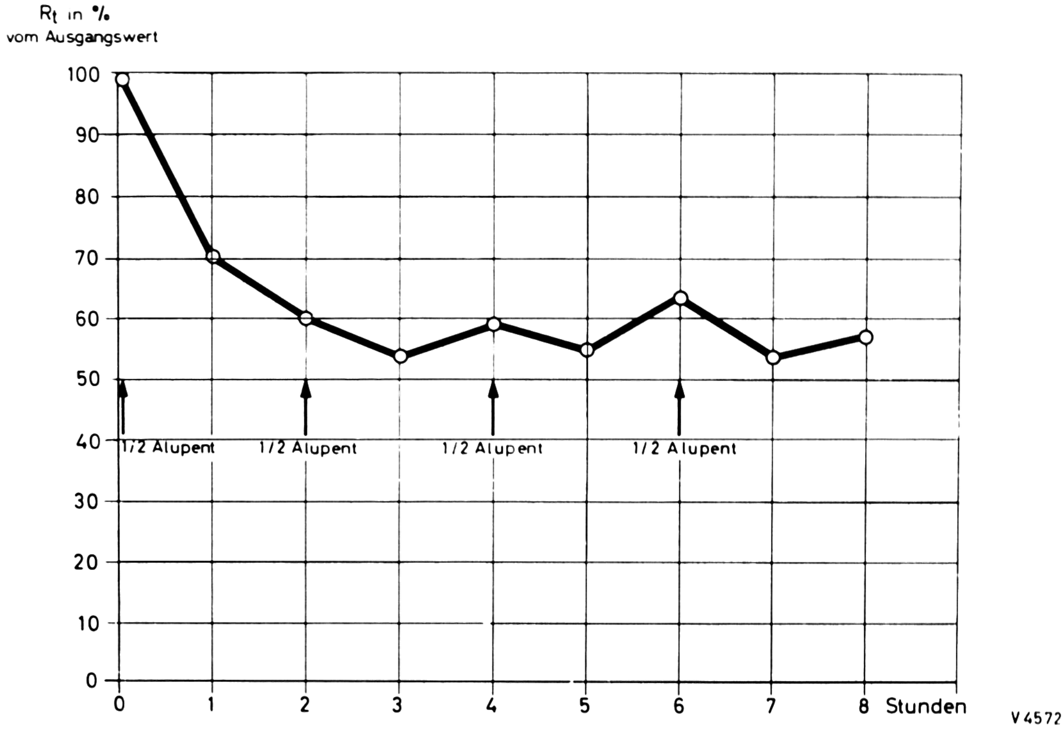


Figure 2 : Examination of the dose dependence of airways resistance (R_t as % of the initial value) with 2-hourly doses of lo mg orciprenaline = ½ tablet Alupent n= lo

This result is very important for the treatment patients. In each case only a certain degree of improvement in airways resistance is possible with these drugs, and if optimal results are not achieved with the standard dose, a further increase in the dose is of no use. The results shown so far all relate to the first group of substances, the catecholamine derivatives, which are known to have a bronchodilator effect.

Meanwhile treatment with other groups of substances has also begun and these are already helping to relieve patients with severe shortness of breath. One group of substances has come to be particularly important; these are derivatives of atropine, a substance that is described as a vagus inhibitor. Biochemically atropine has a quite different specific receptor from the catecholamines. Essentially, however, as research has shown, the dose-effect ratio for this group of substances is the same as for the catecholamines . There is, however, a difference : the atropine derivatives, especially in the form of tropic acid, as in Sch looo (Atrovent (R)), have no systematic side effects. Overdoses, so feared with the catecholamine derivatives, are practically impossible with the atropine preparation Atrovent. The maximum effect is just as strong and just as long-lasting with Atrovent as with fenoterol (Berotec (R)), which is known today as the most effective catecholamine derivative (Minette (1971), Ulmer et al (1973)). Both these drugs, given as aerosols, were shown in Figure 3 in a patient-to-patient comparison.

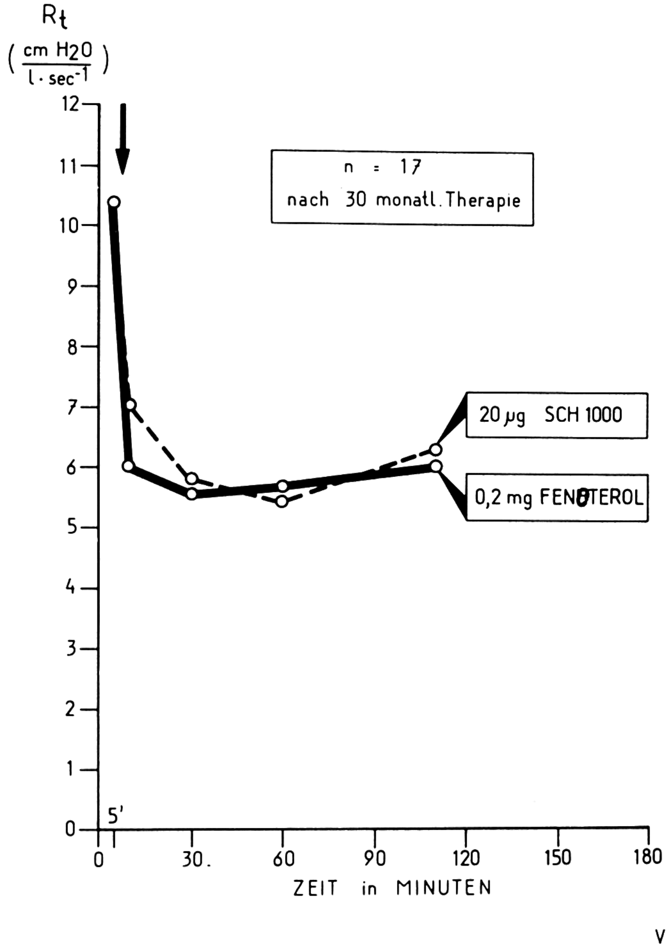


Figure 3 : Sch 1000 (Atrovent (R)) in a patient-to-patient comparison with fenoterol (Berotec (R)) as aerosol in optium dosages. (n = 17) (according to Ulmer et al (1973))

Figure 4 shows similar results from Dr Minette's team. In these methodologically rather different tests with 5o patients, results using Sch looo are at least as good as those obtained with fenoterol. Atropine is also very effective but leads to stronger side effects.

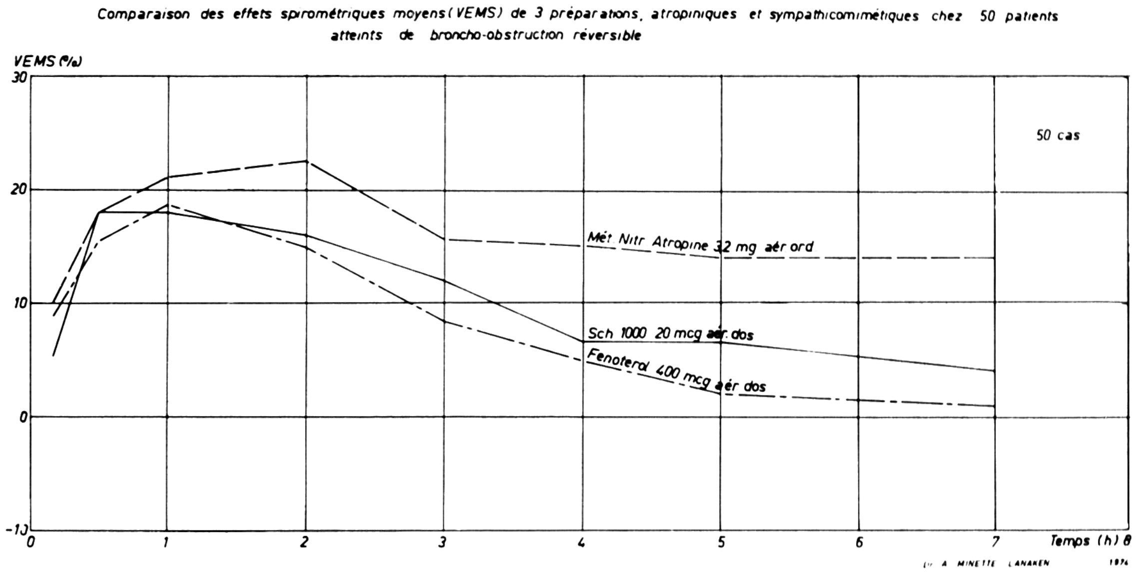


Figure 4 : Sch 1000 (Atrovent (R)) in a patient-to-patient comparison with fenoterol (Berotec (R)) and atropine. Ordinate : rate per second as % of initial rate (according to Minette (1974)).

Figures 3 and 4 also show that the aerosol achieves its full effect in a much shorter time than the tablets (cf Figures 1 and 2). The maximum effect is also achieved with much lower dosages than are necessary with tablets.

Since the catecholamines and atropine are quite different substances with quite different specific receptors this led naturally to the idea of improving the therapeutic effect by a combination of the different substances. Unfortunately, as extensive studies have shown, this cannot be done. Figure 5 sets out to show this by an example in which a combination of the catecholamine derivative fenoterol (Berotec$^{(R)}$) and aminophylline was tried. Aminophylline is also a substance with good bronchodilator properties which again has a quite different biochemical specific receptor.

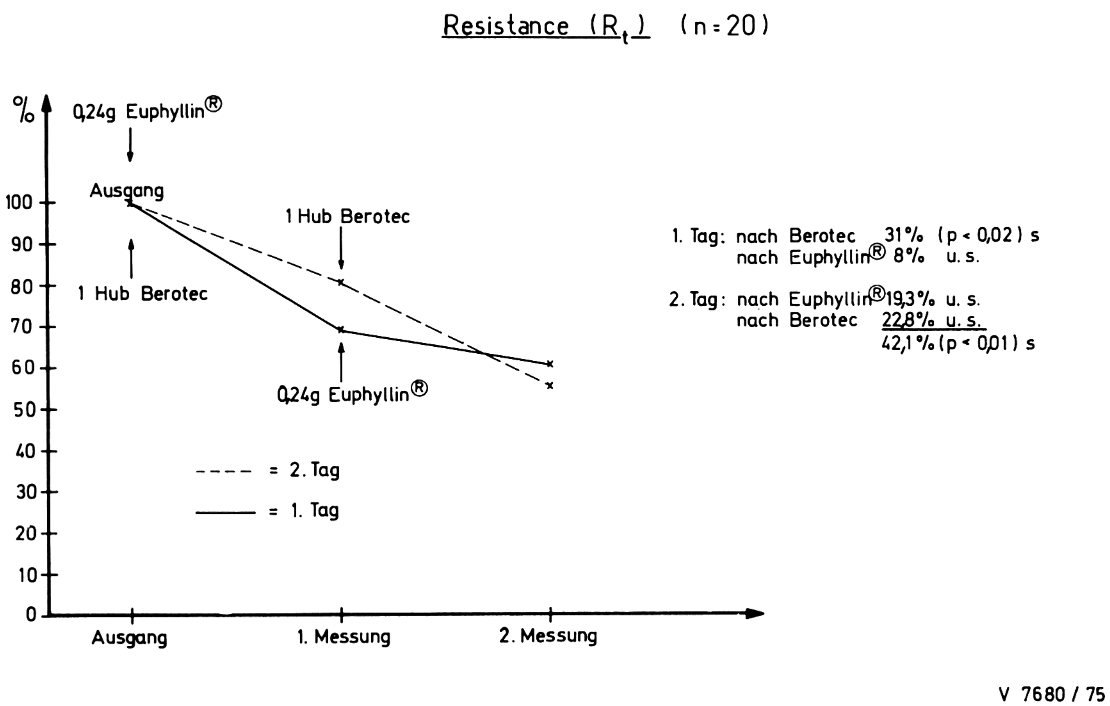


Figure 5 Trial treatment with combined use of fenoterol (Berotec (R)) and aminophylline (Euphyllin (R)) or aminophylline and fenoterol at optimum dosages in a patient-to-patient comparison on two consecutive days (n = 2o)(Kammler's research).

Aminophylline (o.24 g), given intravenously, does not have the same bronchodilator effect as Berotec. The combination of Berotec and Euphyllin, however, does not improve the result that can be achieved with Berotec alone.

Research done at the Clinica del Lavoro in Milan and our own work has shown that airways resistance is subject to a circadian rhythm (De Milles and Ulmer (1971)). Towards the end of the night, even with healthy individuals, there is a marked increase in the resistance. Healthy individuals do not notice as the resistance is still within normal limits. Patients with pulmonary disease, however, may experience violent attacks of breathlessness especially in the early morning. These findings confirm the observation often difficult to understand, that when asthmatic patients call the doctor because of severe breathlessness it is usually towards the end of the night.

Figure 6 shows, for 11 patients with airways obstruction of medium severity, that without treatment readings for airways resistance at 5 a.m. are 50% higher than those taken later in the morning.

Both with the catecholamine derivatives and with the atropine derivative an average reduction in airways resistance of about 20-30 % can be achieved by continuous bronchodilatory treatment with aerosols. The circadian rhythm, however, remains. For both treatment and research it is very important to take account of this circadian rhythm. Thus, patient-to-patient comparisons must as far as possible be carried out at the same time of day.

These results are however also important for a practical reason. The high peaks in airways resistance recorded in the morning help to decide the pattern of bronchial diameter throughout the day. Figure 7 shows findings for 12 patients who began bronchodilator treatment at different times on three consecutive days :
1st day : without bronchodilators; 2nd day: treatment began at 8 a.m., 3rd day : treatment began at 5.30 a.m.
On the 2nd and 3rd days the bronchodilators were then inhaled consistently with optimum dosages at 3-hourly intervals.

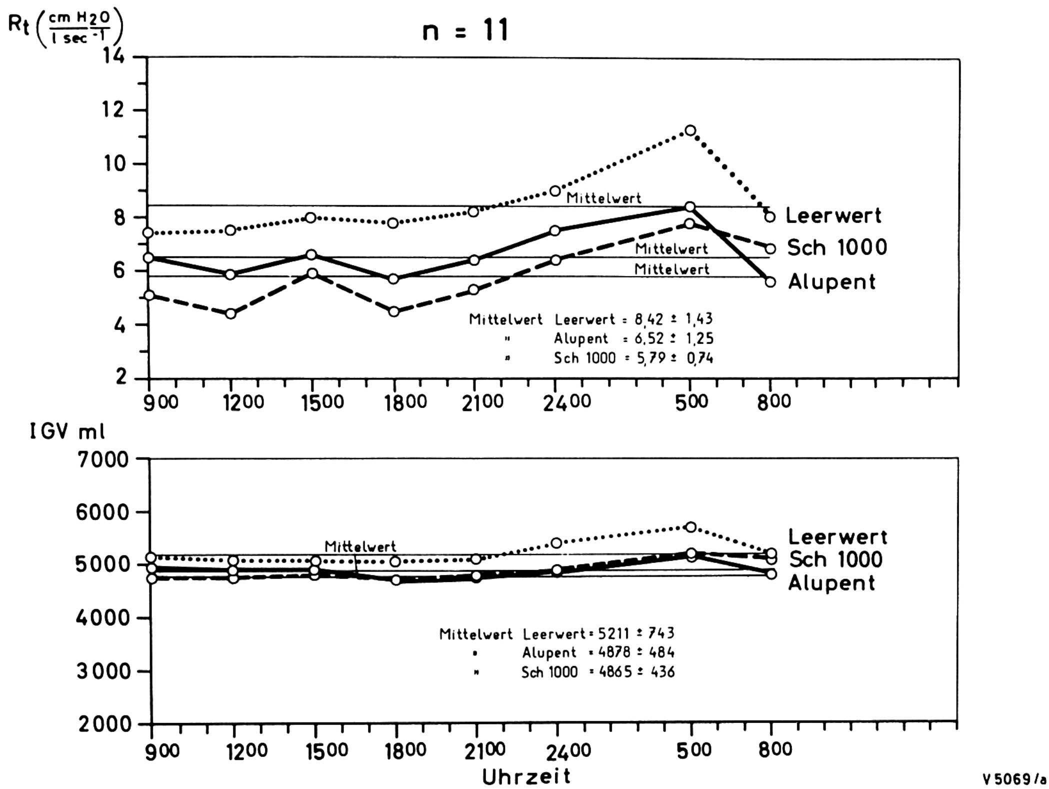


Figure 6 : Circadian rhythm of airways resistance for 11 patients with airways obstruction of medium severity.
Control value without treatment,
Sch 1ooo = with 3-hourly inhalations of Atrovent, Alupent = with 3-hourly inhalations of an Alupent aerosol
(upper curves - airways resistance, lower curves - residual volume)

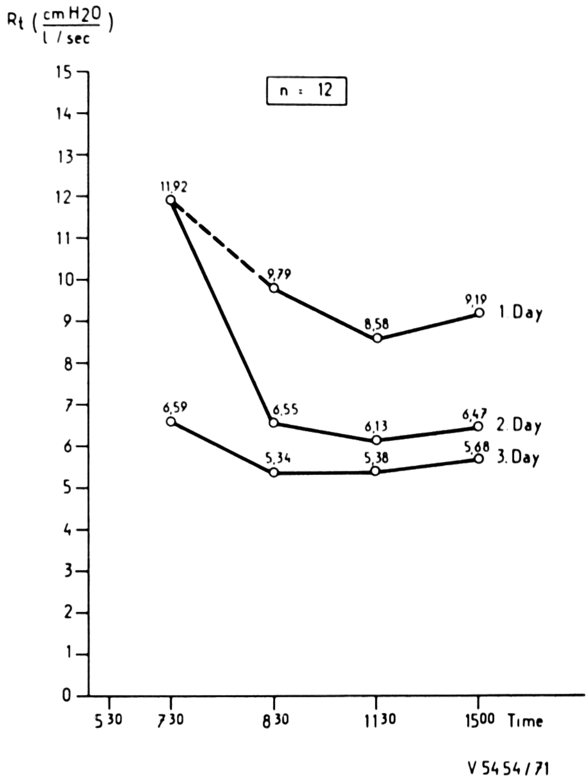


Figure 7 : Airways resistance (R_t) for 12 patients with severe airways obstruction.
1rst day : no treatment
2nd day : treatment began at 8 a.m.
3rd day: treatment began at 5.3o a.m.
Following the beginning of treatment with bronchodilators, further 3-hourly inhalations of bronchodilators with aerosols in optimum dosages.

The Figure shows that developments during the day are best when bronchodilation is begun as early as possible. At any rate the results for the 3rd day are on average 15% better than those for the 2nd day. A comparison between the day witout treatment and days with treatment shows once again how succesful consistent treatment with bronchodilators can be today.

In recent years a distinction has been made not only between alpha- and beta-specific catecholamines but also between $beta_1$- and $beta_2$-specific drugs. In the lung it is mainly the $beta_2$- specific catecholamine derivatives that act on the bronchial muscles (Ariens (196o), Ariens (1964)). Like us, Dr Minette's team in Lanaken has tested out the lung-specificity of the different substances. It was possible to establish a clear order of specificity, going from aleudrin through orciprenaline, hexoprenaline, and salbutamol to fenoterol. A number of other preparations were also tested but these either did not achieve the same results as those already listed or could not improve on them. It is not appropriate to dwell here on these questions some of which are very specialized. These research programmes still hope to find substances that are more specific, freer from side effects and effective over a longer period.

Besides these direct bronchodilators for which only the main results and main lines of research in the various centres can be given here, work has also been done in the Community on a highly interesting substance developed in Britain. This substance also influences the bronchial muscles. Its bronchodilatory effect lies not in relieving a bronchial spasm but in preventing a spasm from occurring in the first place.

Disodium cromoglycate (Lomudal$^{(R)}$ or Intal$^{(R)}$ can specifically prevent bronchial spams arising as a result of allergens (Altounyan (1967, 1969 a + b)).

Research has shown that attacks of asthma caused by occupational allergens can also be prevented, a fact of great importance in occupational medicine. Figure 8 shows the result of this type of research for bakers' asthma.

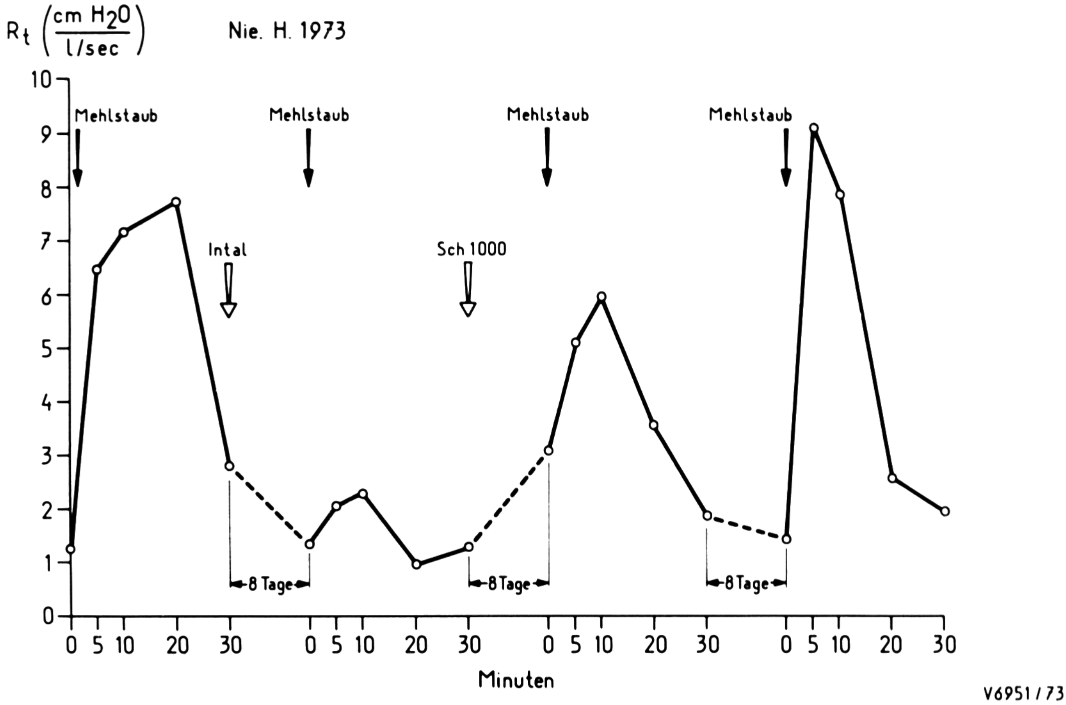


Figure 8 : Airways obstruction caused by inhalation of flour dust (so-called bakers' asthma), which can largely be avoided by inhalation of Intal(R). The atropine derivative Sch 1ooo (Atrovent(R) is not capable of preventing bronchial spasm to a sufficient degree.

Further research will be needed here to see if long-term successes can be achieved. At present we have a small group of asthmatic patients of this sort who are affected by occupational allergens, under long-term treatment and observation (Ulmer 1974)).

It is also important to note that hypersensitivity of the bronchial system to other irritants, apparently brought about by the allergen, can also gradually be reduced by long-term treatment with Intal.

Figure 9 shows how hypersensitivity of the bronchial system to acetylcholine is reduced by treatment with Intal and how the sensitivity of the bronchial system returns to normal about 14 days after the beginning of treatment.

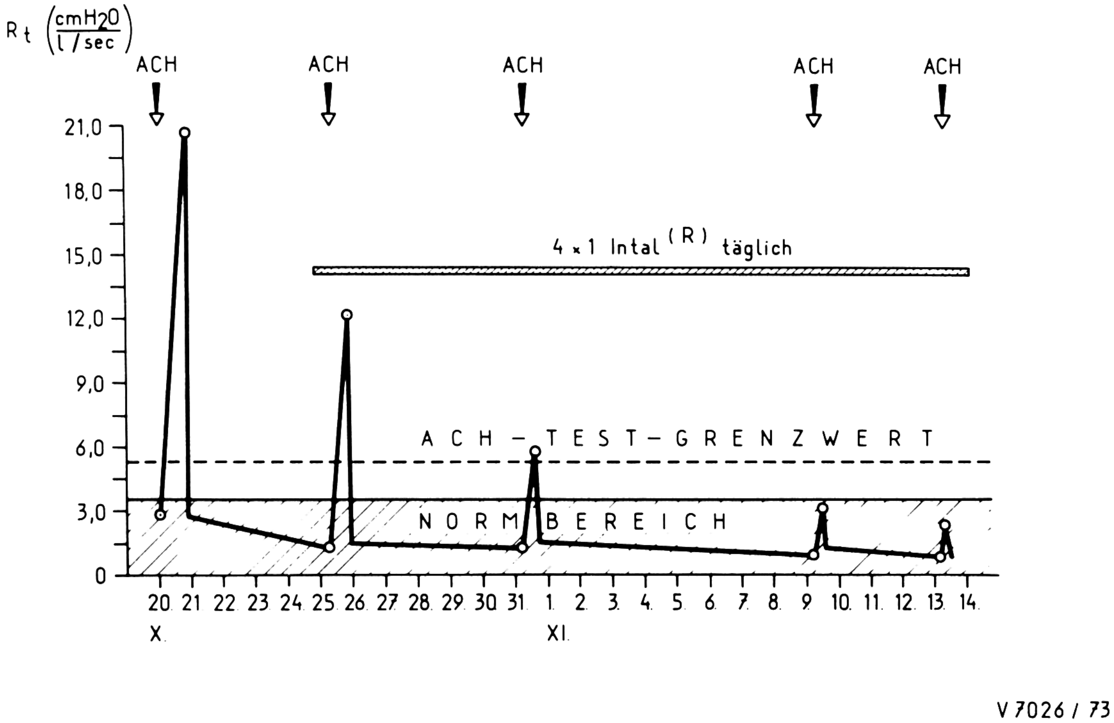


Figure 9 : Hypersensitivity of the bronchial system to acetylcholine in flour dust allergy (bakers' asthma) and the gradual reduction of this sensitivity through long-term treatment with Intal (ACH = Inhalation of acetylcholine in the acetylcholine test; R_t = total resistance (cf Ulmer and Reif (1965)) as a measurement of airways

The last diagram of this report (Figure lo) is designed simply to show how today outstanding results can be achieved with optimal therapy applied at the right time.

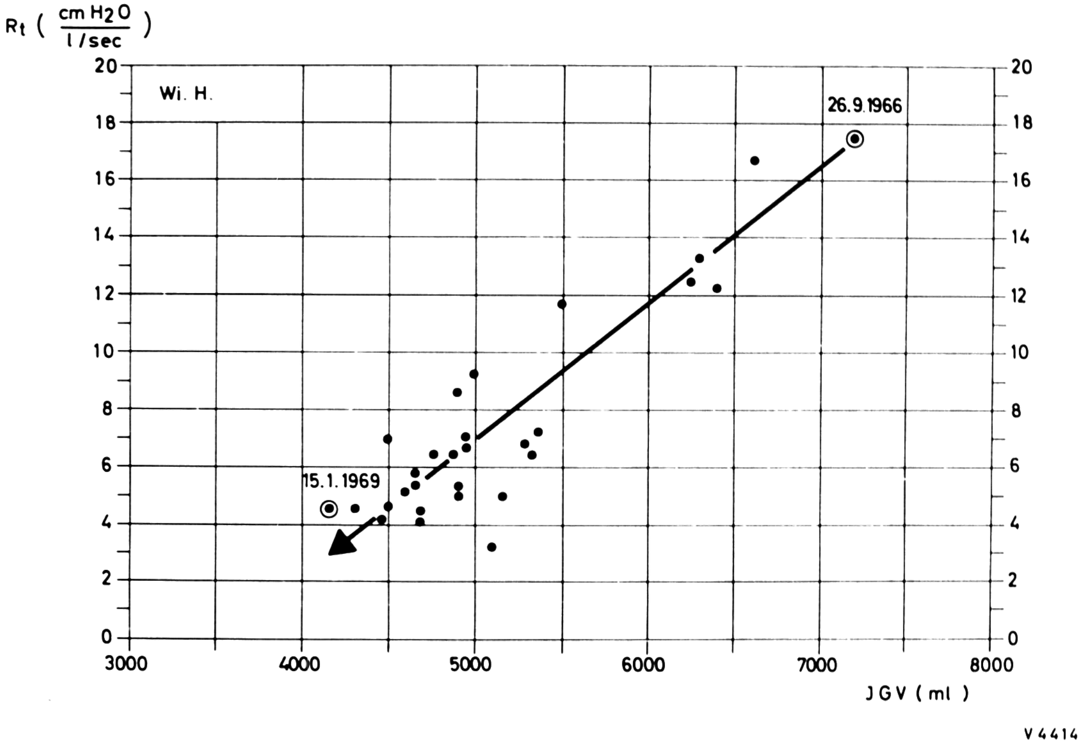


Figure 1o : Relation between airways resistance (R_t) and residual volume (RV) in the course of treating a case of chronic obstructive airways disease. At the end of in-patient treatment (26.9.1966) the result was a long-term normalization of the pathological measurements, and this was maintained over a period of years (last check 15.1. 1969) by continued consistent treatment. Meanwhile further data are available which confirm this result for subsequent years.

As airways resistance decreases, residual volume is also reduced, i.e. the overinflation of the lung decreases (Vastag et al (1972)). It is usually possible to bring the resistance to within normal limits ($R_t < 3.5$) and to maintain this over a period of years by continued treatment.

It happens relatively frequently that such successes cannot be achieved with bronchodilator treatment alone, as has been clearly pointed out in the research done by the team from Naples. In order to achieve such successes it is often necessary, in addition to treatment with bronchodilators as presented within the framework of our research topics, to employ antibiotics, corticosteroid hormones, digitalis and mucolytics.

Further research depends on developing methods for making early diagnosis, establishing the most successful treatment combination for the individual case, and on providing the best possible type of long-term treatment. New methods of treatment can be determined on the basis of available research findings. No doubt further research will bring many fundamental improvements in the treatment of bronchial obstruction. Understanding of the circumstances which lead to obstruction will also be the first step towards finding ways of preventing these illnesses.

Summary :

Obstructive airways diseases are the most common cause of premature disability and absence from work for reasons of illness. In four centres in the Community research has been carried out on drugs which dilate the airways or maintain their patency since constriction of the airways is the main cause of breathlessness in these patients. A number of drugs have been studied in detail as to the duration and intensity of their effects. The results were to a large extent consistent with one another and led to the introduction of new groups of substances for patients with chronic obstructive bronchitis.

The properties of catecholamine and atropine derivatives are demonstrated with practical examples. The importance of the circadian rhythm is discussed as is the importance of beginning treatment in the early hours of the morning. Combinations of different bronchodilators yield no better results than the dispensing of just one of this group of

drugs in optimum dosages. The protective effect of disodium cromoglycate in occupational allergy is demonstrated, using the example of bakers' asthma.

For optimum results it is often necessary at the same time to prescribe other groups of drugs which cannot be described as bronchodilators.

Further research must aim at establishing the diagnosis as early as possible and determing the best form of long-term therapy. The work done so far has provided a far-reaching basis for further forms of treatment.

On the basis of the results obtained and with consistent treatment patients with chronic obstructive airways diseases already have better prospects for a relatively normal and longer life than they had only a few years ago. An important part of this success must be ascribed to the consistent use of the improved bronchodilators.

RESEARCH PROJECTS ON DIFFERENT TOPICS

(Prof. E. FRITZE)

Ladies and gentlemen, I shall now report on three research projects covering different topics. The Pernis group has used experiments on animals to study the effects of contamination of the air by irritant gases such as SO_2, and dusts such as inert coal dust and iron oxide dust, on the local immunological defence system, in this case the animals' tonsillar tissue sensitised by streptococcal antigens. It was found that SO_2 significantly impaired the local immune reaction and local immune defences, whereas inert coal dust and iron oxide dust in fact stimulated local immune defences, acting like adjuvants.

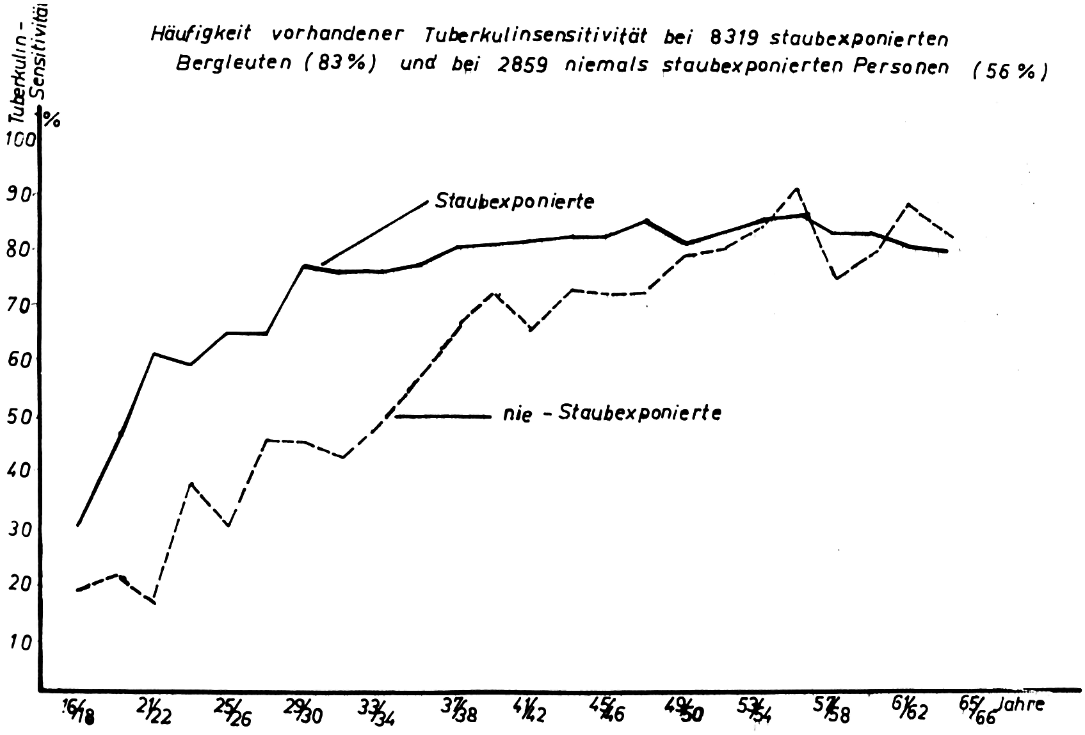
In chronic bronchitis the physiological cleansing processes in the respiratory tract are often overtaxed and secretions accumulate in the airways and hinder the exchange of gases. This can affect the central nervous system. These cases of respiratory insufficiency are often combined with cardiac insufficiency, and treatment can be extremely difficult, especially as the secretions cannot always be removed satisfactorily by straightforward drainage. However, in the cases in view of the severe risk its presents, the blocked airways can be cleared by lavage. In this treatment, physiologically buffered saline solutions are introduced into one lung and then drained off, while the other lung is kept breathing by means of breathing apparatus. The other side can then be lavaged either immediately, or at another session. In this way it is often possible to remove much of the matter secreted in the bronchial tree and to improve the patient's breathing. Because of the large reabsorption area, the lavage fluid cannot always be drained off completely, and for this reason it should not be left for too long in the airways, and we usually administer a diuretic after the treatment in order to eliminate the fluid.

This treatment has been tried in some twenty severe cases where there was danger to life, without incident. An improvement in breathing occured in most cases although this was only transitory. Metabolic parameters and arterial blood gases also improved. The complications of pulmonary lavage are the considerable reabsorption of lavage fluid, which I have just mentioned, and the possibility of atalectasis of one of the lobes of the lung caused by occlusion of a bronchus by the material which is being removed. This can be relieved by repeated lavage. In the hands of an experienced physician this treatment is relatively free of danger and is of great therapeutic value in suitable cases.

I now come to the third report, again on our own research, in this case concerning the positive tuberculin reaction in coal miners exposed to dust and control groups from the same area who had never been exposed to dust, all from the Ruhr.

The starting point of this study was the high frequency of active tuberculosis in miners suffering from silicosis. Inthe years 1962-1973,the frequency of cases of active silico-tuberculosis was 8 - 17 %, or an average of 13 %, of all cases of silicosis. Even though these figures may not be completely accurate, because the reference values are frequently incorrect, it would nevertheless be reasonable to assume that the frequency of tuberculosis in miners is at least 5%, compared with a frequency of only approximately o.o5 to o.1% in the rest of the population of the Federal Republic, although here too, of course, some of the figures are debatable. A study of persons insured with the Bundesknappschaft, the miners' insurance fund, showed that in 43o ooo persons not exposed to dust, the frequency of tuberculosis was only o.o5%. We must therefore assume - and this is borne out by clinical practice - that tuberculosis is particularly frequent in subjects exposed to dust. The purpose of our epidemiological research, which has been going on since 1966, is to determine whether this high frequency of tuberculosis is in fact due to infection with tuberculosis of miners exposed to dust, that is, to already-existing positive tuberculin reaction without overt tuberculosis. Our research team studied approximately 12 ooo persons, comparing active miners with office employees and similar groups of persons who had not been exposed to dust. It goes without saying that persons who had suffered from tuberculosis or had been inoculated against it were eliminated. An incidental finding of these studies was that BCG inoculation does not confer positive tuberculin reaction for longer than lo or possibly 12 years at the most. The results of these tests on miners and comparable groups of persons who had not been exposed to dust are all shown on this slide. It can be seen that the frequency of positive tuberculin reaction in 8 3oo miners was on average 83%, while the rate of infection in the 3 ooo subjects who had never been exposed to dust was 56%. The The **x** axis shows age classes, the corresponding percentage frequency of positive tuberculin reaction beeing shown on the **y** axis. It can be seen that the miners who had been exposed to dust showed a positive tuberculin reaction more frequently than the control group, from an early stage, when they had only been working underground for from a few months to 1-2 years. The occurrence of positive tuberculin reactions increases very rapidly over the next few years, and approx. an 8o% infection rate is found in the 29-3o age group, compared with a level of just under 5o% in the non-miners.

Other research which I shall not describe in detail has shown that the higher frequency of positive tuberculin reactions in miners as compared to other groups cannot be attributed to a particularly high environmental risk of the miners being infected by tubercle bacilli. It seems more likely that actual exposure to dust encourages the development of positive tuberculin reaction, in other words - and this hypothesis is based on experimental findings - with simultaneous exposure to dust, even a small quantity of tubercular antigen is sufficient to cause sensitisation, in a way that would not be possible without simultaneous exposure to dust. But the frequent occurrence of tuberculosis and silico-tuberculosis among miners cannot be explained simply in terms of this marked sensitivity to tuberculin and of a very frequent finding of a positive tuberculin reaction. It is a common but unproven theory that an existing positive tuberculin reaction is a sign that the body defences against the disease are particularly good. In actual fact, the presence of a positive reaction only shows that the subject has been in contact with tubercle bacilli; and the large number of miners exposed to dust who react positively to tuberculin also no doubt includes the potential cases of active tuberculosis. One hypothesis that could be tested by animal experiments and in vitro tests is that the macrophages which ingest not only the tubercle bacilli, but also dust (and quartz dust seems to be particularly significant here), are irreversibly damaged by the absorption of quartz particles. Although this is still only a hypothesis, we feel that the cytotoxic effect of the dust could well be the cause of the more frequent positive tuberculin reactions. What conclusions can be drawn from this, as far as prophylaxis is concerned? The question is whether the frequency of tuberculosis in miners can be reduced by regular and repeated BCG vaccination. I can imagine that this might present some practical difficulties, and in any case we do not know what effects the BCG vaccination may have when combined with the inhalation of dust during mining work - as you know, there have already been several unexpected reactions. An alternative method of prophylaxis would be to have annual tests for tuberculin reaction as soon as conversion is noted, that is, when the tuberculin test turns positive, subjects should be given prophylactic treatment with tuberculostatic drugs, while continuing at work. It will be for future research projects to decide which of these alternatives is the more practicable.


Häufigkeit vorhandener Tuberkulinsensitivität bei 8319 staubexponierten Bergleuten (83 %) und bei 2859 niemals staubexponierten Personen (56 %)
Tuberkulin-Sensitivität
%
100
90
80
70
60
50
40
30
20
10
Staubexponierte
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16/18
21/22
25/26
29/30
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45/46
49/50
53/54
57/58
61/62
65/66
Jahre

DISCUSSION

Prof. Antweiler

I have a question concerning Dr Ulmer's last slide. I believe he showed the therapeutic success of a treatment along the ordinate using the resistance of the airways as a criterion, and that he showed lung volume along the abscissa. The improvement in airways resistance is accounted for by the absence of bronchospasm, but I do not understand the shift to the left of the lung volume along the abscissa. Is this due to an improvement in the morphological changes caused by emphysema, or is there some other explanation?

Prof. Ulmer

You have already provided the answer, Mr Antweiler. Any increase in resistance results in an increase in lung volume, and the elimination of this resistance reduces lung inflation.

Dr. Dechoux

I would like to ask Mr Orie a question. I seem to have understood that he had very poor results with anti-bacterial vaccines. For our part, we have administered vaccines of the CCB type for some 15 years to hundreds of patients. I think it can be said that these vaccines are effective in certain conditions. On the one hand, vaccination must be carried out regularly, summer and winter, so that stimulation is constantly maintained. On the other hand,it cannot be applied to patients whose cases are too serious and who have reached a stage that they can no longer drain their lungs and are constantly infected, such as patients with bronchiactasis.

Prof. Orie

Since this question concerns research carried out by Mr Voisin, who is present, I think it would be better for him to reply personally.

Prof. Voisin

I would like to thank Mr Orie for giving me the opportunity to clarify a point quite rightly raised by Mr Dechoux. I fully share Mr Dechoux's opinion. Mr Orie did not have the time, in the short paper he presented, to give all the details of the research we have been carrying out. In the final version of our text, and in other publications which I will gladly hand over to Mr Dechoux, we state that the patients we treated by vaccination, either locally or systemically, were not in fact good subjects in this context. They were hospital patients, and in their cases the local lesions were such that the vaccine was no longer likely to have much effect. Moreover, the patients did not show any antibody deficiency which could be detected by measuring the level of circulating immunoglobulin or any decrease in the immunoglobulins in the bronchial secretions. We are at present advocating vaccination trials in the work environment, where we can find subjects whose lungs are still only minimally affected, on whom the anti-bacterial vaccine can have some effect. The experiments that we are now conducting on animals in fact show that these vaccines have a real influence on the resistance of the respiratory system to bacterial infection.

Dr Dechoux

I would like to ask Mr Ulmer a second question about bronchodilators. I consider that you have clearly shown the effects of these substances, especially those of catecholamines. I would also like the doctors present here today to be told how dangerous these substances are. You have already mentioned this information, but the point must be stressed. We have all observed the very serious and very harmful effects of these substances, especially in severe cases, as for example, in asthmatics who always carry a pocket inhaler and may use it at any times.

Prof. Ulmer

You are right. It is a question of dosage. We must know exactly how far we can go. But it must also be said that with the beta-sympathomimetics that we have today, the risk is less. What you say is especially true of isoprenaline.

Dr. Dechoux

May I make one more point? For the last 15 years, miners in Lorraine have been vaccinated with BCG before going underground. This is an experiment which, in my opinion, might be worth following up one day.

Dr Amoudru

I would like to come back to this point. In one of the papers we have just heard, it was pointed out that the frequency of positive reactions to tuberculin is greater in population exposed to dust than in control populations. This is a finding that we have confirmed, but the interpretation of which could be discussed at length. On the other hand, there seems to be no doubt that BCG vaccination of this group does not involve the drawbacks suggested some time ago by certain publications which, clearly, did not take into account the epidemiological evidence. In the North, an extensive compaign of BCG vaccination, led by Professor Gernez-Rieux with the scientific and technical collaboration of the Pasteur Institute, has been carried out among the mining population. This vaccination has, moreover, been carried out systematically in Lorraine for a long time. We can certify that this vaccination has produced no side-effects other than those generally encountered in all BCG statistics, and even these are remarkably rare. On the contrary, it seems that a higher degree of protection against tuberculous complications and tuberculosis in general is achieved among these populations. Consequently, I would not like the industrial medical officers present today to leave here under the impression that this method has been challenged, discussed and found to involve substantial risks for personnel, because the facts contradict this. I think that this must be made quite clear and that it is necessary for us to adopt firm positions which will prove useful to the day to day practise of industrial medicine.

Prof. Fritze

I did not say that vaccination had disadvantages. What I said was that it had not been proved that vaccination actually has a positive effect on adults. I do not question the value of BCG vaccine in babies and children, but important American studies show that the frequency of tuberculosis in adults is identical, whether they have been vaccinated or not. What I wanted to say was that the problem warrants further research. It would be very interesting for us to have the detailed results of this method of prevention of tuberculosis in adults.

5. REHABILITATION

Rapporteur general : Prof. H. DENOLIN (Brussels)
Rapporteurs : Prof. L. BRASSEUR (Leuven)
Prof. D. CASULA (Cagliari)

INTRODUCTION
(Prof. DENOLIN)

The increasing incidence of chronic pulmonary diseases and their often quite considerable effect on morbidity and mortality, particularly in certain groups of workers, indicates that we should do all we can to try to reduce the physiological, psychological and social consequences of such diseases. The aim of rehabilitation is to develop a series of new approaches aimed at reducing the repercussions of these diseases so that patients suffering from chronic pulmonary disease can - in the words of the World Health Organization - "occupy as normal a place in society as possible using their own resources".

The concept of rehabilitation should be present in the doctor's mind from the onset of the illness; it should be applied to all the patient's problems and should always be considered as a multidisciplinary adjunct to traditional methods of treatment and secondary preventive measures.

Aware to the importance of this problem, the Commission of the European Communities therefore included in its programme research projects on the development of rehabilitation methods and on the analysis of their results. Research centres in Bochum, Brussels, Cagliari, Louvain, Nancy, Palermo and Recklinghausen have taken part in this study.

It was obviously impossible initially to cover all the factors involved in improving the functional condition, in solving psychological problems or in dealing with social considerations such as the identification of work suited to the patient's clinical state or giving him a new occupational classification.

In the research carried out so far, emphasis has therefore been placed on methods of improving the respiratory function and overall physical condition of patients suffering from chronic pulmonary disease.

An initial study carried out by the Recklinghausen group aims to show that regular medical surveillance, traditional methods of treatment and the correction of aggravating factors such as smoking may well improve the patients subjective state and some of his functional parameters; however a longer period of follow-up will be required before those conducting the research can assess more accurately the extent to which these simple, traditional methods of treatment are benificial.

However, the Working Party on Rehabilitation has been mainly concerned with the physiological effects of a programme which, in addition to the usual methods of therapy, includes physical training. In this connection, an agreed research protocol was drawn up and applied in a number of centres. The results obtained will be presented by Mr Brasseur and Mr Casula.

INFLUENCE OF A PROGRAMME OF RESPIRATORY PHYSIOTHERAPY AND PHYSICAL TRAINING ON PULMONARY FUNCTION

(Prof. L. BRASSEUR)

This report lists the principal results obtained by the six groups who took part in the research into the physical rehabilitation of patients suffering from chronic respiratory insufficiency.

Even though the various centres generally observed the selection criteria and the methodology which had been agreed before the research started, there were occasional difficulties in assessing the results. The patients' average age and the way in which their pulmonary function had been impaired on the one hand, and the type and duration of the programme of physiotherapy and effort training on the other, varied considerably.

The results of these programmes on pulmonary function are evaluated on the basis of six categories of test :

- static lung volumes;
- dynamic lung volumes and pulmonary mechanics;
- carbon monoxide diffusion;
- maximum exercise tolerance;
- blood gases, partial oxygen and carbon dioxide pressures, both at rest and on exercise;
- results of cardiac catheterisation and haemodynamic data, both at rest and on exercise.

Static lung volumes

The Brussels, Cagliari, Nancy and Palermo centres detect an improvement in the vital capacity and in the residual volume following physiotherapy on its own or, more commonly, following physiotherapy combined with training of the muscles.

According to the Brussels and Nancy researchers, this improvement is maintained if the physiotherapy is maintained for from 6 months to 3 years.

Dynamic lung volumes and airway resistance

Some centres detected either a rise in FEV_1 or a reduction in airway resistance as a result of physiotherapy alone.

Carbon dioxide diffusion

No change was reported.

Maximum exercise tolerance

The Cagliari, Palermo and Brussels groups detected a significant increase in maximum oxygen consumption following physical training, indicating an improvement in physical capacity. This effect was also detected by the Nancy researchers, as a result of physiotherapy alone. It appears that the degree of improvement in physical capacity is essentially linked to two factors: a poor initial physical condition on the one hand and mild disturbances in the blood gases on exercise, prior to training, on the other. The improvement in the maximum effort tolerance and in physical capacity often leads to a return to work, as was shown by the researchers at Cagliari. Palermo emphasized the importance of improvements in the working environment in a return to work.

Blood gasses at rest and on exercise

The research carried out at Nancy, Cagliari and Brussels showed an improvement in the oxygenation of the arterial blood at rest or even on exercise, sometimes as a result of physiotherapy alone. In other cases, however, there was no change.

Results of cardiac catheterisation and haemodynamic data

The Brussels and Louvain groups did not observe any change in the post-training cardiac output of those patients who before training and pulmonary arterial hypertension if only on exercise. Pulmonary arterial hypertension on exercise was unchanged.

Conclusions

1. The cardio-pulmonary functional parameters did not deteriorate in any of the studies. This point is very significant, as it was not in fact possible to exclude a priori the possibility of physical training having an adverse effect on the oxigenation of the arterial blood and on pulmonary hypertension. In addition, long-term studies reveal a stabilisation or even a slight increase in the spirographic figures.

2. In most of the studies maximum oxygen consumption and physical capacity improved following training, to a varying degree. This is an important factor in connection with return to work.

3. Oxygenation of arterial blood sometimes improves, especially at rest.

4. The haemodynamic datas changed litte following physical training.

5. All these results were obtained from relatively old and

relatively handicaped subjects. The Lanaken centre has undertaken a study of the effects of physical rehabilitation on younger and less seriously affected miners. This research will tell us whether the results of physical rehabilitation are more impressive if undertaken early in patients whose pulmonary function is less seriously affected.

THE EFFECT OF EFFORT TRAINING ON THE OVERALL PHYSICAL CONDITION

(Prof. D. CASULA)

As Prof. Denolin has announced, I shall give a brief account of the effect of retraining, and, in particular, of effort retraining, on the overall physical condition.

Table I lists the more important examinations carried out on patients at four of the centres involved in this research programme (Brussels, Cagliari, Louvain, Nancy) in order first to determine the stability of the illness and subsequently to examine the results obtained at various stages of the rehabilitation therapy. The table shows that all the centres measured lung volume and CO_2 elimination, carried out an analysis of the arterial blood gases at rest and during exercise, and evaluated physical ability by means of a maximum effort tolerance test.

Some centres also measured airway resistance and pulmonary mechanics, and two (Brussels and Louvain) studied the pulmonary blood circulation at rest and during exercise.

The second table shows the rehabilitation techniques used and summarizes the results obtained with regard to physical ability.

As can be seen from the table, effort retraining is carried out at two of the centres (Brussels and Cagliari) exclusively by means of an ergometer bicycle, used also by the other centres but in conjunction with other types of physical exercise (walking, running, rowing, gymnastics, climbing up and down stairs etc).

Retraining sessions vary in frequency from three times a week to once or twice daily, with a duration varying from 2o minutes daily (Cagliari group) to 6o minutes per session (Louvain group). The intensity of the work during the training sessions is specified by three centres (Brussels, Cagliari and Louvain).

The effort imposed is very similar, corresponding at the Brussels and Louvain centres to approximately 75% of the maximum oxygen uptake, and at the Cagliari centre starting with a relatively lower intensity (6o% of the maximum work performance) which is increased as the patient's physical ability improves.

The duration of the programme varies according to centre and case (from twc to fourteen weeks) but the information obtained indicates that the total duration of the retraining cycle should not exceed 7 - 8 weeks to achieve optimum results.

An increase in physical ability is noted by all the research groups. In the case of the Nancy group this increase might be due to both respiratory retraining and muscular retraining as the two methods were used simultaneously, whereas, in the case of the other three groups it can be attributed solely to physical retraining since the effect of effort retraining was studied separately using other methods.

The results of the four studies, each of a high standard and carried out strictly according to a given methodology, therefore tally in that they show that retraining leads to an increase in physical ability which may vary, but is, nevertheless, statistically significant. This increase in physical ability is generally **accompanied** by an improved mental outlook.

What are the factors which improve the physical ability of subjects suffering from chronic pulmonary disease undergoing rehabilitation?

First of all, there is no doubt that an improvement in respiratory function, which can be attributed to closer medical supervision and a more judicious choice of drug treatment on the one hand and to physiotherapy on the other, may form the basis of effort retraining with a view to improving the physical capacity of these patients.

This increase in physical capacity is reflected by the statistically significant increase in oxygen consumption and by the power developed or, as in the case of the Louvain group, by the ability to sustain more intense and/or more prolonged efforts.

After a period of retraining, most work is performed with less hyperventilation, a reduced respiratory rate, an absolute or relative drop in the heart rate, an increase in PaO_2 during exercise and/or at rest and a reduction in $PaCO_2$ both at rest and during exercise.

Although it is not possible at the present time to draw conclusions as to the value of the processes which improve physical ability, the results so far obtained from the four research programmes mentioned would seem to indicate that much of the patients' improved physical ability can be attributed to peripheral processes of a neuromuscular type (better coordination of movements, an increase in the thickness of the muscular fibres, better peripheral vascularisation with a resulting increase in the capacity of the muscles to extract oxygen); furthermore, an important part is probably played by the changes which retraining brings about in respiratory and cardiovascular function. In other words, retraining could also improve the respiratory function of chronic respiratory invalides, as it does in normal subjects; this is borne out by the relative reduction in the respiratory rate with improved alveolar ventilation and respiratory exchange during exercise (as is shown by the increase in PaO_2).

This process alone improves the metabolic condition of the muscles by reducing the production of lactic acid, and by limiting the acidifying effect of this metabolite.

The relative fall in the heart rate, which occurs with the same work loads and which does not rise when these are increased, suggests that despite conflicting opinions on the subject, an increase in the systolic output also takes place in the case of chronic respiratory invalides making it possible to maintain or increase cardiac output without provoking an excessive fall in the circulation time.

Further and more thorough research is obviously needed to confirm these hypotheses, but the results of the research programme tally, showing that effort retraining provides a valuable contribution to the fulfillment of a rehabilition programme for men disabled by chronic pulmonary disease.

EXAMINATIONS CARRIED OUT DURING THE VARIOUS OPERATIONAL REVIEWS OF THE EFFECTS OF RETRAINING

Centres	Brussels	Louvain	Nancy	Cagliari
Spirography	+	+	+	+
Residual volume	+	+	+	+
Bronchodilator	-	-	-	+
DL. CO (or TCO)	+	+	+	+
Airway resistance	-	+	+	-
Arterial blood gases at rest	+	+	+	+
Maximum effort tests $\dot{V}$, $\dot{V}O_2$, $\dot{V}CO_2$, R, CF, RF	+	+	+	+
Sub-maximum effort tests	+	+	+	-
Blood gases during : a) maximum effort b) sub-maximum effort	 - +	 - +	 - +	 + -
Hemodynamic measurement of the pulmonary circulation	+	+	-	-

TABLE I

RETRAINING TECHNIQUES USED BY THE DIFFERENT WORKING PARTIES AND RESULTS OBTAINED REGARDING PHYSICAL CAPACITY

Centres	Brussels	Louvain	Nancy	Cagliari
Number of cases	11	11	17	33
Type of training	Ergometer Bicycle	Running Gymnastics Rowing Ergometer Bicycle	Walking Stairs Ergometer Bicycle	Ergometer Bicycle
Numer of weekly sessions	3	3	12 (2 daily)	6
Duration of sessions	25'	60'	30'	20'
Intensity of effort	75% VO_2 SL	75% VO_2 SL	not specified	60% VO_2 MaxE
Duration of the programme expressed in weeks	non specified	14	2 - 6	6 - 8
Increase in physical ability	10% P = 0,05 (20.5% in 4 cases)	Significant P = 0.05 - 0.001	Significant P = 0.01	50% P = 0.001

TABLE II

CONCLUSION
(Prof. H. DENOLIN)

Now that you have heard the reports from Dr Brasseur and Dr Casula you will realize that for patients whose lung condition has already become fairly severe, physical training results in only minimal changes in their circulatory and pulmonary function at rest but certainly does not cause any deterioration. On the other hand, there is absolutely no doubt that the proposed training programmes improve the overall physical condition of the patients - though to varying degrees. This is shown by an increase in their maximum O_2 consumption or at the very least by their performance.

These results explain the feeling of well-being experienced by the patients during the therapeutic programme as it enables them to live - or work - but now using a smaller proportion of their maximum potential capacity.

Physiologists are of course concerned to understand the processes whereby this improvement is achieved. Some of the data collected by the Working Party seem to indicate that physical training - as in the case of healthy individuals or cardiac patients - may primarily improve the metabolism of the peripheral muscles by allowing more efficient use of their O_2 supply.

However, we still require further information about circulatory function, particularly that of the heart muscle. The Bochum group has therefore conducted research on coronary circulation and myocardial metabolism in subjects suffering from chronic pulmonary diseases. This revealed clear abnormalities (increased extraction of oxygen from the blood) whose mechanism and significance require further research. The Brussels group, for its part, has done work on myocardial contractility which has shown how difficult it is to assess the functional state of the right ventricle, a low pressure cavity, and to identify the initial stages of chronic cor pulmonale; furthermore, these research projects have not yet shown any evidence that certain aspects of the clinical pattern can be ascribed to a left ventricular failure except perhaps in cases of severe hypoxia.

From the various research projects carried out, it follows that a rehabilitation programme definitely benefits patients suffering from serious chronic pulmonary disease. While the situation is improved somewhat by medical treatment and secondary prevention, physiotherapy - which may involve various aspects - promotes subjective improvement and to some extent corrects functional deficiency. Finally, physical training has the advantage of increasing the functional capacity of the patient, so that life is easier, and - as the Cagliari group has shown - helps him to return to an active working life.

On the basis of these positive results we are already in a position to recommend and draw up physical training programmes for subjects whose functional deficit is already apparent; even at this stage we are aware of the limitations and possibilities offered by these new methods of treatment.

However, the research projects carried out and the results obtained have of course also shown the extent of the problems involved and the number of questions still to be answered. In this connection, we would stress the value of studying younger subjects at a less advanced stage of the illness in order to improve the results of physical rehabilitation, an essential precondition for improving social rehabilitation. We need more accurate information on the effects of physiotherapy and physical training. We already understand the effects of respiratory reeducation on the distribution of inspired gas, on lung capacity and blood gases yet the energy expenditure, the haemodynamic effects and long-term repercussions of this kind of treatment still need to be studied. The same is true of oxygen therapy.

We should also consider setting up a better co-ordinated study of pulmonary and cardiac function in patients, many of whom have reached the age of cororary insufficiency, in order to define more closely the indications, contraindications and the required of standards physical training programmes. The state of the pulmonary circulation and of the right ventricle should be considered in the same light in order to decide whether physical activity has any effect on the level of the pulmonary arterial pressure and the development of chronic cor pulmonale.

These are just some of the clinical and physiological problems which need to be resolved, but other aspects which require investigation: the effect of these programmes in preventing relapses, on prognosis and mortality; the psychological aspects of the illness, the consistency with which patients follow the programme of treatment and their willingness to avoid aggravating factors; the validity of occupational reclassification by objective comparison of the subject's remaining capacity and the energy and ventilatory requirements of a given job; definition of institutions able to implement rehabilitation programmes, their structure, staff,etc.

In conclusion, we may say that the Working Party on Rehabilitation has obtained positive and coherent information, particularly on the physical and pulmonary rehabilitation of respiratory insufficiency, but many problems still need to be solved.
We have not of course given any details of the methods of treatment or the numerous technical problems and difficulties involved in a research programme of this kind, particularly regarding the methods used in exercise tolerance tests and related examinations.

Professor Lavenne has also mentioned the contacts which must be maintained between the various research programmes.

DISCUSSION

Dr Vidali

I should like to put a question. I listened with great interest to your reports which were concerned in particular with the physiological aspects which are fundamental to rehabilitation, since its aim is to improve the subjects' physical capacity for life and work. If however such measures are to be completely satisfactory from the rehabilitation point of view, they should be complemented by genuine research into the results achieved.

What type of patients were studied? Were they still working? Were they coming to the end of a course of medical treatment? Were they about to stop working because of illness?

What do these patients think of the treatment they received? What is their point of view on the advantages of this rehabilitation treatment? It is certainly very important for these persons to manage to live while using a smaller proportion of their maximum capacity, as Professor Denolin rightly said. But I think that, in the case of rehabilitation, results should also be assessed by the patients. Physiological measurements alone are not enough.

I should like to put a third question. What is the opinion of the health authorities responsible for these patients? Indeed it would be pointless to try to rehabilitate patients unless there were some sort of future in it, which should in my view be guaranteed by the health authorities.

Prof. Denolin

Mr Chairman, these are important problems, some of which I mentioned in my concluding remarks. In the introduction to my report, I said that rehabilitation was multidisciplinary and could have no value unless all an individual's problems - physiological, psychological and social - were taken into consideration.

It has not yet been possible to attend to much more than the physiological problem and aspects, except in individual centres.

The results of the psychological and social approach have so far been too divergent for us to present an overall picture.

In several centres, Brussels in particular, we investigated the psychological strategy required by these patients, who pose extremely difficult problems. We have many years' experience in rehabilitating patients recovering from myocardial infarctus. This is, however, a much simpler matter than treatment of a subject with chronic lung disease, since myocardial infarctus strikes a person suddenly, often in the midst of an active life, and he is much more amenable to guidance from psychologists and doctors.

Since chronic lung diseases take a long time to develop and deterioration is slow and progressive, the psychological approach is much more difficult and a greater number of patients fail to complete their rehabilitation programmes. The patient's attitude plays a more important part in this case, which explains why the tables we have just seen showed that only a relatively low proportion, one sixth or one tenth, of the subjects initially investigated actually completed the programmes. This is a very serious problem.

As regards the matter of the type of subjects investigated, we agreed, as I mentioned, to select patients whose respiratory function had already deteriorated considerably. None the less, some of them were still at work. Indeed this was the case with most of the Nancy group which consisted of slightly less serious cases than the other groups. This is indisputably a very important problem for the future; we must discover to what extent subjects can be aided if treated a lot earlier.

As regards returning to work, Mr Casula has put forward statistics showing that subjects who have followed a rehabilitation programme are much more likely to return to work. This is of course true of rehabilitation for all diseases, whether traumatisms, coronary heart disease or lung disease. If an active interest is taken in all the patients' problems, their reintegration into society is much more successful. Reintegration does indeed depend on many factors: age, length of previous disablement, occupational qualifications, the labour market, etc. I do not have to dwell on this point.

Finally, I did not quite understand your question about the health authorities. Whom do you mean?

Dr Vidali

The health authorities are evidently different from one country to another. I was simply thinking that, where rehabilitation is recognized to be a useful activity and is appreciated by the subjects involved, it should be considered at the first stage of disease and disablement, as soon as the disease is discovered. It should be systematically planned and organized from that moment on. Insurance and compensation funds should be informed of these techniques and their results.

Prof. Denolin

Mr Chairman, this is all grist to our mill. I would perhaps go a little farther. In my opinion, although I am very interested in the rehabilitation of internal diseases patients, the term rehabilitation should cease to be used in years to to come. Complete treatment should be considered as an indissoluble whole, which means that secondary preventive measures, drug therapy, kinesitherapy, physical training and the solution of psychological and social problems should form a whole. Rehabilitation, which is at present at the research stage and is seen as an isolated sector, should become merged with all the other therapeutic measures.

Dr. Amoudru

I should first like to thank Mr Denolin and his fellow speakers for a report which was remarkable far in its clarity and freedom from esoteric scientific terms. We were presented with concrete facts which I think are of interest to all the participants, not only the functional specialists among us. I should like to make my own small contribution to what has just been said and, to quote the expression used, bring a little grist to your mill. I am going to tell you very briefly about the experience in our functional rehabilitation centre, the Maison du Mineur in Vence, where we use the rehabilitation techniques developed by Messrs Sadoul and Gimenez in particular.

About 4oo patients per year attend a two-month course of treatment. Their average age is 5o years and their illness is at a relatively advanced stage as was the case with your patients. The results in brief are as follows : as regards functional tests at rest, the improvements are, as you found, only slight, about 7 to 1o%. There is thus no irrefutable proof of outstanding results in this respect. However, if we consider the self-sufficiency of the individual and his capacity for effort, the gains are much greater. Individuals show great satisfaction after attending a rehabilitation programme which requires their participation and their willpower is much greater. Clearly, the results of certain measurements are not consistent with the objective overall assessment of the general physical condition. It will not go into the problems what this implies.
I should simply like to answer Dr Vidali's last question by

stating that 50% of the subjects, without medical prompting, spontaneously request to take part in new programmes each year. This certainly shows that handicapped workers are in favour of the programmes. I think that this is a relevant point which needed to be mentioned. Thank you, Mr Chairman.

Prof. Brasseur

My comments are on the same lines as those of Mr Amoudru and I shall attempt to answer, as did Mr Denolin, the highly complex question put by Dr Vidali. The summaries of the different research reports are of course limited to lung function and improvement of physical condition, to the exclusion of other aspects which cropped up in all the projects : very marked subjective improvement, evident feeling of well-being, reduction of the sensation of dyspnoea, improved tolerance of effort in daily life, increased motivation to resume work or other activities, benefits due to stimulation of emulative spirit in group kinesitherapy exercises or retraining. Finally it is important that these patients with chronic lung disease, who are very disillusioned and sceptical, should come to accept medical treatment more readily, including a certain amount of guidance and hygiene in their daily life.

Prof. Casula

I should like to add a few words to confirm the possibilities of rehabilitation, while diswrongly false hopes. This is evidently a highly complex problem which must be regarded from all angles, that is from the very first stage of kinesitherapy and training to the very last. There is no doubt that rehabilitation and its results may now be considered as real and proven. But it is essential to obtain full functional recovery, that is recovery of normal physical capacities. This would not mean that a patient could start work again immediately. Recovery of physical capacities should be complemented by rehabilitation in the social context, since handicapped persons in centres for respiratory diseases are evidently cut off from society. They must be reintroduced into working life. As we have seen, some of them are able to resume work, but often not the same kind of work in the same working environment, since they would again be exposed to harmful factors. A new job and working environment must be chosen, and this is a complicated problem, which cannot be solved by doctors. I feel that what Dr Vidali said is highly relevant. What is the opinion of the health authorities? But what about the political authorities too? This is, after all, a problem which must be also solved at the political level.

Prof. Brasseur

One last attempt to answer Dr Vidali's questions. In some countries, including Belgium, the authorities are showing an increasingly positive attitude to rehabilitation. The Belgian national fund for the social rehabilitation of the handicapped has for some years now been exercising a very positive influence on aid to the handicapped and encourages all centres attempting to rehabilitate various types of handicapped people. In our country, some of the authorities have taken a decision in this matter and are following it through.

Prof. Orie

I should like to emphasize your point that therapy and rehabilitation are complementary. But we must be realistic. I think we must remember - figures were given earlier this afternoon - that a considerable proportion of persons suffering from respiratory diseases receive only indifferent medical care, if any. However great attempts to rehabilitate them may be, the search for adequate parallel therapy should also be given priority.

Prof. Denolin

Mr Orie, I am in complete agreement with you. The idea is not to establish the proportion share of each type of therapy. Medical treatment, secondary prevention, that is the elemination of aggravating factors, physical rehabilitation, psychological help and the solution of social problems should form a whole, the proportion of each element probably depending on the individual patient. In some the psychological problem will be most important by far, in others perhaps medical therapy will predominate ..... The aim in my view is to have as soon as possible a single integrated unit of connected measures, which would of course be adapted to the needs of each patient.

EPIDEMIOLOGICAL RESEARCH INTO RESPIRATORY DISEASES IN THE BRITISH COAL INDUSTRY.

Dr. D.C.F. MUIR, Edinburgh

For over twenty years the British Coal Industry has been conducting a major research investigation into the health of miners. The results have been published in a number of reports and reviews. It is not the purpose of the present paper to describe the details of these findings but rather to define the basic reasons for carrying out the programme and to consider its relationship to the practice of occupational medicine.

Occupational medicine is concerned with diseases resulting from an occupation. Other diseases are important to the occupational physician if they have a special relevance to the ability of a man to undertake a task with safety to himself and to others. There may be other important aspects such as those connected with rehabilitation and so forth. However, occupational medicine is not concerned with the treatment of diseases that happen to occur in a worker but which are unrelated directly to his occupation. To take some examples. A miner who has a myocardial infarction underground presents acute problems. It is difficult to render immediate help and it is difficult to transport him to the surface. Rehabilitation in the industry after hospital treatment requires careful consideration. These problems are the province of the occupational physician. On the other hand, it is not his responsibility to be an expert in the details of treatment while the man is in hospital. At that stage his illness is in no way different from any other patient with heart disease and the occupational aspect is of little importance. Chronic bronchitis presents another example. This is a common disease in miners as in other sections of the population. Only those features of the disease specific to the mining environment are encompassed by the science of occupational medicine. The treatment of the disease is not included in this because this does not differ from that of any other patient with bronchitis. This is particularly evident when dealing with advanced stages of the disease if the man is clearly unlikely to return to mining.

This distinction between occupational medicine and general medicine is important in defining the responsibilities of an individual doctor and, particularly, in defining the terms of reference of a research project.

A given doctor may decide to accept responsibilities in both fields. An industry may find it convenient or desirable to employ him to do both. He may specialise in occupational medicine, and, at the same time, carry out general medical duties among the employees. This is a common practice where entreprises employ large numbers of men in remote areas lacking in medical facilities. In Britain it is unusual for industries to employ physicians with general medical duties because of the existence of a comprehensive National Health Service which undertakes these responsibilities. On the other hand it is the rule to provide health care at the work place in some other countries.

These various arrangements may have an historic origin or may be merely a matter of convenience. Many doctors moreover, accustomed to clinical work, are not anxious to relinquish the satisfaction associated with this type of work. However, the distinction between occupational and general medicine assumes very practical importance in the design of research projects. All research, to be succesful, must have clear objectives and terms of reference. Failure to distinguish occupational medicine from general medicine may cause endless confusion in a given project.

These considerations were taken into careful consideration when planning the National Coal Board research programme into respiratory diseases in working miners. It was, and still is, evident that the only way to control pneumoconiosis was to provide a safe atmosphere underground. The function of the occupational physician was to advise the mining engineer as to what levels of dust, of dust composition, or concentrations of other pollutants could be regarded as safe. No amount of exotic research into the minutiae of pulmonary or cardiac function were likely to assist in answering these questions. A comprehensive epidemiological survey of approximately 30,000 miners was therefore started in 1952. Nearly all miners at selected collieries were examined radiologically at intervals and, in more recent years, by means of pulmonary function tests and respiratory symptom questionnaires. At the same time detailed estimates of each man's environmental exposure were kept. Great efforts were made to examine complete working populations at each colliery. To answer the practical questions posed at the start of the inquiry it was, of course, quite useless only to examine men referred for specialist opinion because they were breathless or had other clinical symptoms.

The rigid protocol proved highly successful and has enabled dust standards to be introduced into the industry with a scientific biological and environmental basis. For the first time it was possible to estimate the amount of pneumoconiosis that would be associated with any particular level of dust underground.

Much remains to be done. The importance of the composition of the dust and of the concentration of underground gases is now being examined. The relevance of emphysema and of related disorders such as bronchitis is being investigated. This second stage of the research is being undertaken with the co-operation and support of the Commission of the European Communities. It is hoped that the enlarged programme will be even more fruitful in the years ahead and will be beneficial to all our partners in the Community.

SYNTHESIS AND CONCLUSION

by Professor G. WORTH

Ladies and Gentlemen,

Throughout yesterday, five meetings were held in parallel sessions. In these sessions all the research projects on chronic respiratory diseases carried out under the four-year programme 1971-1974, which is partly financed by the Commission of the European Communities were the subject of thorough, frank and sometimes tough discussions. The chaimen and rapporteurs of these sessions have reported to you to-day on the individual research themes. It is now my job to sum up once again the basic results in order to show you where the difficulties were, the progress that has been a-chieved, and what further tasks lie ahead of us.

First may I take this opportunity of thanking very sincerely all those people who helped to promote this research. As doctors and research workers we have a highly responsible task to accomplish in the scientific study, prevention and treatment of these important chronic broncho-pulmonary dis-eases. It is true that we can formulate the questions, point out the problems and work out ways of solving them; but it is equally true that the practical realisation of these aims costs money - a lot of money, especially where epidemiologi-cal investigations on thousands of people are involved. As it was the decision-making bodies of the Commission of the European Communities who willingly provided the funds we applied for, I hope that today will show that their decision was correct.

In particular I should like to thank Dr Hentz who has carefully, vigorously and skillfully co-ordinated the carrying out of this research and has, in so doing made a fundamental contribution to the results achieved.

Ladies and gentlemen, let me recapitulate in reverse order and begin with the question of rehabilitation, as this aspect is the one that many of you are most closely concerned with.

The assessment of effective measures for the rehabilitation of patients with chronic lung diseases naturally poses serious problems, as the development of these diseases, which is characterised by frequent relapses, is very changeable and, in individual cases, unpredictable. In order to get reliable results here, we must first make a comparison between groups of patients who have received treatment and those who have not, the groups must be reasonably big and there must be relevant criteria on which to make a judgment. As there were no scientific data in this particular field, it was absolutely essential to carry out some carefully programmed research.

The work of Messrs. Brinkmann, Casula, Denolin, Frada, Lavenne and Sadoul shows that patients with chronic bronchitis may be improved as a result of physical training, although a corresponding improvement of other cardio-pulmonary functions could not be shown in all cases.

All results of investigations should be viewed critically and it should be realised that in order to obtain a final assessment of the value of rehabilitation in chronic bronchitis, post-treatment observation must cover a fairly long period of time to establish to what extent the tendency to relapse, and therefore the further progress of the disease, has really been diminished.

In the case of treatment with drugs Dr Minette and Prof. Vigliani have tested new products, **Parasympathomimetics** and Betasympathomimetics, the use of which will nowadays produce an improvement in almost every case of respiratory obstruction. By getting his patients to use steroid inhalers Prof. Vigliani believes that it is possible to do without oral or parenteral doses of steroid. Animal experiments have enabled Prof. Ulmer to show that the bronchial muscles which are under control of the vagus nerve play a major role in cases of bronchial obstruction and that atropine and its derivatives are therefore the best way to reduce bronchial tone. It has also been shown that bronchial hypersensitivity is due to proteolytic enzymes, histamine, serotonin and prostaglandin F 2.When the bronchial passages are blocked with mucus, with risk to life, Dr Fritze recommends the lung lavage procedure involving the washing out of the bronchial tree of both lungs with a buffered solution of sodium chloride.

Research carried out by Prof. Voisin has shown that vaccination of bronchitic patients with an antimicrobial vaccine has no effect on the frequency of relapses, at least in the later stages of the disease. Analysis of those disturbances of the defence mechanism of the respiratory system which are responsible for infectious relapses does not show any humoral, general or local immune deficiency, but it does show the importance of disorders of the phagocytic defence mechanism in connection with toxic episodes or attacks by airborne virus.

Meaningful prophylaxis and therapy can be based only on precise diagnosis, which should take place as early as possible. Consequently a great deal of research time was devoted to the development and standardisation of the research methods required, particularly with a view to their application in industrial medicine. Standardisation, which has been the concern of Dr Cara, is necessary because there must be comparable diagnostic criteria in all the countries of the Community, and also because both the assessment of the success of particular treatments and the objectivity with which they are evaluated must be based upon uniform methods and criteria. In this respect the measurement of the CO transfer factor, carried out by Messrs. Dechoux, Pham and Bollinelli, has been of special interest in recent years because this method, which is relatively easy, has turned out to be a very comprehensive criterion for assessing the various forms of disturbance of respiratory gaseous interchange.

No less important for the assessment of bronchial obstructions are methods of investigating breathing mechanics. The extremely important and valuable process of body plethysmography, which has told us so much about flow resistance in the respiratory passages, has the disadvantage of being expensive and complicated. Dr. van de Woestijne and myself at Moers have used the oscillation method which, though it does not provide such an exact measurement of bronchial obstruction, costs very little. It would seem to be thoroughly recommended for the general practitioner.

The method of continuous analysis of expired air was simplified by Messrs. Maugeri and Serra. It permits early diagnosis and is also suitable for epidemiological field studies.

Dr Petit has developed a very method for determining the closing volume by interrupting respiratory flow. This has already led to the commercial production of the apparatus and is of value in the early diagnosis of peripheral obstructions.

However important it may be, by using the simplest possible parameters to make an early broadly based diagnosis, it is equally important in individual cases to arrive at an accurate differential diagnosis so that appropriate therapy can be instituted. In the case of cardiac patients, bronchitic patients and patients who have dyspnoea on exertion as a result of lack of exercise we have looked for differences in functional disturbance patterns and we have found them above all in exercise tolerance tests. In cases of doubt it seems to us that the cause of exercise dyspnoea can only be established through a tolerance test and not through a test carried out at rest. Finally, while on the subject analysis of function, we must mention the investigations with cardiac catheters undertaken by Dr Rosenkranz. These showed that the oxygen pressure in the coronary vein of patients in a condition of advanced silicosis was lower both at rest and on exercise than in patients with other lung diseases or in healthy people.

Let us now turn to epidemiology which is an essential method of research for determining the causes of chronic bronchitis and pulmonary emphysema. We know today that these illnesses can arise from many very different causes and in individual cases we have not so far been able to isolate clearly the various factors. For this reason the quantitative significance of smoking, air pollution and occupational exposure to dust and irritant gases, as well as the incidence of allergies, can only be explained through epidemiological comparisons of their frequency in groups which differ from each other in one or more of these factors. This was the aim of the greater part of the reserach.

Messrs. Brinkmann, Casula, Deniau, Minette, Sadoul, Sessa, Zannini and our own team concerned themselves principally with industrial exposure to dust in the coal and steel industries and established unanimously that evidence of chronic bronchitis and lung emphysema is found far more frequently, and in some cases twice as frequently, in coal workers, than in men of the same age and from the same geographical region and with the same smoking habits who are not exposed to dust. In steel workers there was significantly more bronchitis the higher the dust and irritant gas levels at their place of work, although they are not as frequently or as seriously affected as the coal workers. Prolonged studies in coal miners, carried out by Dr Ulmer and Dr Brinkmann, will naturally only be evaluated in some years.

In the case of workers exposed to cadmium, Dr Lavenne discovered on average a definite reduction in the parameters of spirographic functions. The same tendency was reflected in the research carried out by Mr Maugeri and Mr Frada on workers from different industries. Dr Bollinelli has moreover compared inhabitants of industrial areas with those from rural areas and found that the latter showed bronchitic symptoms in 5% of the population, only half the frequency in the former. Dr Crepet observed the same in children. Mr Orie stresses in his study, the deleterious effects of SO_2 on the lung.

Many of the above mentioned aspects are noted in the epidemiological study of Dr van der Lende, who also comes to the conclusion that even a short term increase in atmospheric pollution leads to measurable disturbances in lung function. In a large series he examined people from a rural environment and from a highly industrialized area three times over a period of ten years. This clearly showed the deleterious effect of air pollution on the respiratory passages.

In subjects with a skin allergy respiratory symptoms were not more frequent so that in his opinion allergy factors do not play an important role in accounting for the different incidences of bronchitis.

In the opinion of Pernis, the higher frequency of bronchitis in areas with a polluted atmosphere is to be explained, on the evidence of morphological, immunological and histochemical experiments carried out on the lymph systems of guinea pigs and rats exposed to gases, smoke and dust, by the fact that inert particles of dust favour infection, perhaps because the antigen particles are retained in the lymphatic tissue longer through the effect of dust.

Fundamental research has been dominated in the past to a very significant extent by the possibility of treating silicosis with PVNO. Some years ago it was shown by Mr Schlipköter's team in Düsseldorf that the appearance of new areas of silicosis could be significantly reduced or even completely prevented by PVNO. This has since been confirmed by the work of many other researchers. These results led to the hope that at last effective prophylaxis and therapy for miners threatened by or suffering from pneumociniosis could be carried out. But one must make a fundamental distinction between silicosis caused by quartz dust and that resulting from a mixture of dusts, such as coal miners' pneumoconiosis. Dr Weller was able to show after many years of experiments on monkeys that PVNO had neither a prophylactic nor a therapeutic effect in cases of mixed dust silicosis (he administered a mixture of 60 coal : 40 quartz dust)

In a certain sense these findings were confirmed by the macroscopic and microscopic research carried out by Dr Könn on five miners who died from severe anthraco-silicosis which had been treated with PVNO. In no cases did the findings differ from the syndrome of untreated anthraco-silicosis.

The chances of effectively combating silico-tuberculosis have been increased through the epidemiological studies of Dr Fritze's working party. Examinations of several comparable groups, to-talling 12,000 persons in all, showed that active tuberculosis in miners suffering from silicosis is 200 times more frequent than in persons who have never been exposed to dust. It also showed that the frequency of a positive tuberculin reaction is on average almost twice as high in the people exposed to dust as in the control group. It is reasonable to suppose, on the basis of the results of these investigations, that the process of tuberculin conversion begins in the first months of exposure to dust. Dr Fritze recommends annual tuberculin tests on each man from the beginning of his mining career and recommends that in cases where tuberculin conversion has begun, a prophylactic tuberculostatic treatment should be instituted without interrupting work. Protective inoculation is worthy of consideration as an alternative.

In the field of fundamental research, biochemical, immunological, histological and morphometric investigations have been carried out. Dr Schlipköter believes that the increase of phospholipids in the lung is the earliest hitherto demonstrable biochemical change brought about by the effect of quartz dust (rats' lungs). Mr Vigliani's investigations show that the development of silicosis in SPF rats is slower than with conventionally bred rats, that is to say those whose lungs are rich in pathogenic organisms. He attributes this to the fact that the immunological system has been fully occupied by other factors. Experiments carried out at the Institut Pasteur in Lille by Professors A. Tacquet and B. Devulder, in collaboration with CERCHAR, had demonstrated the role of mycobacterial infection in the contraction and the rapid growth of massive pulmonary fibrosis. The hypothesis that this microbial interference in the development of the fibrous lesions might be of an immune nature had been considered. Recent work by this group of research workers has in fact confirmed the view that such lesions are a reaction to relatively non-pathogenic bacteria, taking the form of an inflammation which proliferates on account of the weakness of the immunological defence system of the organism and is related to the cytotoxic mineral particles that have been inhaled.

Mr Klosterkötter has established that for similar mineral contents, the cytotoxicity of the samples of fine dust is all the greater the older the geological strata from which they come. These findings agree very well with the epidemiological investigations carried out in the Ruhr area and in the Saarland.

Mr Graille distinguishes, in simple forms of mixed dust silicosis affecting coal miners, two principal types of bronchial lesions : One causing bronchiectasis and the other causing stenosis. The overall coniotic charge is on average stronger in the first group than in the second. Dr Delannoy (CERCHAR) reports on two kinds of emphysema: atrophic emphysema and emphysema which is conditioned by fragmentation of the alveolar walls.

Research carried out by Professor Degand on the structure of bronchial mucoids and the effect of different glycosidases of bacterial, vegetable or cellular origin on these mucoids, as well as the qualitative and quantitative study of the proteins of human bronchial secretions, constitutes a new way of approaching bronchial physiopathology.

Ladies and gentlemen,

What may we now conclude from the results of these complex and expensive research projects? As far as the use of PVNO in the prevention and treatment of pneumoconiosis in human beings is concerned, we must wait for the results of further experiments on animals. The experiments should by particularly concerned with the most common form of mixed dust silicosis in our countries, namely coal-miners' pneumoconiosis. At the same time the side effects of PVNO must be further elucidated. The proof of the effectiveness of the substance in the treatment of mixed dust silicosis and awareness of possible side effects are conditions that must be satisfied before we can accept the responsibility of using it in treatment or prophylaxis on human beings.

It is equally urgent for us to continue our study of chronic pulmonary diseases. In order to make maximal progress we must pay particular attention to early diagnosis and prevention. Viewed in this light, research into causes and prevention become in the long run of even greater significance than rehabilitation, with which we only really concern ourselves when the disease has reached the stage in which reversibility is no longer possible. Of particular interest in the research undertaken by Messrs Voisin and Dechoux is the nature and significance of the infection, the basic mechanisms of obstruction and possible treatment at each stage of development of the disease.

These questions are not only of importance for non-specific broncho-pulmonary diseases but also for diseases peculiar to particular industries, as, for example, asbestosis, farmers lung and last but not least coal miners' pneumoconiosis.

First we must weigh-up, concentrate and coordinate our programmes in a much more self-critical manner and much more efficiently. This is particularly urgent in the case of epidemiological studies on chronic bronchitis because of the extremely high expense that they entail. A precondition for this is careful planning of research and standardisation of methods as well as a rational limitation of the work. I attribute a special significance to standardisation in future research so that we in the countries of the European Community may be able to speak the same language both from a scientific point of view as well as in clinical medicine, through the use of uniform methods and standard criteria of assessment. Perhaps we should take the extensive and valuable experience of industrial doctors more seriously into consideration. In this context, we ought to aim in future for a closer cooperation with doctors in clinical practice as with individual research centres.

Ladies and gentlemen,

The Commission of the European Communities has always been very much aware of its moral and ethical obligation to promote the good health of workers in these often dangerous industries of coal and steel and it has effectively supported all the research tending to this aim. To continue these efforts should be for all of us a task of the first importance.

INDUSTRIAL MEDICINE

Current topics in the Industries of the Community

RESEARCH ON CHRONIC RESPIRATORY DISEASES IN OCCUPATIONAL MEDICINE

Dr. A. MINETTE, Lanaken

Research on chronic respiratory diseases in occupational medicine has four main objectives.

1. Above all, we must stress the imperative need for research aimed at a better understanding of the exogenous und endogenous factors causing chronic respiratory disease in workers. Indeed, there are still many gaps on our knowledge and it is obviously important, for more effective prevention of respiratory diseases, to fill them. Here it is particularly important to identify the air pollutants specific to working premises, and to study the long and short-term reactions of the respiratory system to these substances.

2. Research should also concentrate on finding the best possible ways of identifying the early symptoms of chronic respiratory diseases and diagnosing these diseases at an early stage. Progress in this direction would enhance the effectiveness of pre-employment examinations as subjects already suffering from incipient respiratory disease could be diverted from dangerous work; it would also favour more appropriate relocation of workers to non-dangerous work as soon as the first symptoms were noted.

3. Another aim of research should be to improve our under-

standing of the repercussions of these diseases at each stage of their development. Progress in this direction would allow fairer appraisal of the subject's remaining capacity for work, and hence more appropriate relocation of workers with these diseases; it would also contribute to fairer, more balanced assessments of the compensation to be awarded for damage to health.

4. Finally, in spite of the fact that under most countries' legislation industrial medicine does not have any curative purpose, it is clear that research on therapeutic aspects would be very useful. It stands to reason that progress in this field will help to alleviate residual disablement and thus contribute to better re-integration into the labour market of workers who have suffered from these diseases, with all the human and socio-economic advantages this represents, both for individuals and for society as a whole.

I. PREVENTIVE RESEARCH

A distinction must be made, in the coal mining and steel industries, between pneumoconiosis and broncho-emphysema diseases.

a) Pneumoconiosis

At present the prevention of pneumoconiosis is essentially a matter for non-medical research, and priority is given to research projects studying the best ways of preventing the formation of suspended toxic particulate in the air, and ways of precipitating suspended matter out of the atmosphere at some point between its source and the respiratory systems of the exposed workers. In practice, these technical studies may be combined with medical research on the penetration of harmful particles into the respiratory passages and the subsequent elimination of these substances. All the same, until recently the prevention of penumoconiosis seemed to be virtually exclusively dependent on the improvement of technical measures for dust control. The prevention of tuberculosis was, so to speak, the only medical exception to this rule. It had been known for some time that in a number of cases, a tubercular complication can spark off the transformation of a simple form of pneumoconiosis into the condensed form.

In any case, tuberculosis is still a dangerous complication, causing serious infirmity, and any research projects likely to contribute to early diagnosis, prevention or treatment are worthy of the utmost interest.

The discovery, several years ago, of polyvinylpyridine-N-oxide has, even today, a great influence on the ideas of researchers interested in the medical prevention of pneumoconiosis. Certainly, this product inhibits the toxic effects of pure inhaled silica in experimental animals, and very probably also in man, and it was therefore hoped that it would be possible to use drug treatment to prevent silicosis in groups of workers exposed to inhalation of this substance. However, the prophylactic effect of the product is apparently less marked with pneumoconiosis caused by mixed dusts from collieries than with pure silicosis. More details on the effect of the drug in man would obviously be useful. However, although preventive tests on workers are at present quite justifiable on ethical grounds, in view of the low toxicity of the product, it is extremely difficult in practice to organize tests of this kind. The delays - currently very long delays - in the appearance of pneumoconiosis in coal miners, mean that tests have to extend over long periods (approximately 2o years, in the opinion of many researchers) before any appreciable results are available. Also, the high turnover of underground workers, in our continental countries at least, and the fact that a large number of them do not work in collieries for particularly long periods, are of course major obstacles to the organization of such long-term research programmes. Nevertheless, in the immediate future research might well be carried out in parallel with these preventive tests, on the possible stabilizing effects of the product on extensive evolutive pneumoconiosis in coal miners. Tests of this kind appear to be easier to organize than purely preventive tests, but the greatest care must be taken in selecting treated groups and non-treated control groups so that the results are representative, and the tests should only be carried out with the full knowledge and agreement of the subjects concerned.

b) Bronchitis and emphysema

Here the prospects of medical prevention are more favourable than for pneumoconiosis.

To begin with, we would like to point out that innumerable epidemiological studies have proved that cigarette smoking with inhalation of smoke is extremely harmful and can lead to chronic respiratory disease. But so far these findings have not been followed up by practical measures in works, although there would be an opportunity for particularly effective prevention, without great financial outlay, in the form of well-designed anti-smoking campaigns. Indeed, it is virtually certain that giving up cigarette smoking would in many cases eliminate the first clinical signs of bronchitis and would in almost all cases considerably increase tolerance of bronchitis already contracted.

Having said this, the prevention of bronchitis and its emphysematic complications in workers always, like pneumoconiosis, entails technical investigations to identify the respirable pollutants present in working premises.

After this phase of technical identification, one can move on to medical studies of the short and long-term damage of occupational pollution in man, in order to eliminate the agents that cause respiratory disease. Also, this medical research frequently has to be closely linked with technical investigations, for information on points such as grain size, the penetration of particles in the respiratory passages and the extent of pulmonary clearance capacity for these particles. Medical research on these topics is usually based on investigation patterns of the prospective or transverse epidemiological type. But the subjects could also be studied in more fundamental research programmes in the laboratory, and even with tests on animals.

From another angle, there is now good reason to believe that the development of methods for stimulating the natural defence mechanisms of the respiratory system could lead to a method for preventing bronchitis and its emphysematic complications. It would now be feasible to stimulate defence reactions by acting on the mechanisms that control infection with appropriate vaccines. But the selection and use of these vaccines, both the products to be used and the methods of administering them, still pose major problems and require intensive investigation. There is also a need for research to develop methods for neutralizing the endogenous factors causing bronchial hyperreactivity in many subjects. The attenuation of this tendency to abnormally acute bronchial reactions would of course help to reduce the biological harmfulness of toxic inhalations.

II. STUDY OF THE EARLY SYMPTOMS AND SIGNS OF CHRONIC RESPIRATORY DISEASES

A great deal of research is necessary in this field.

It is fair to say that the early detection of the parenchymal diseases that show up in X-rays,such as pneumoconiosis, is now very efficient. Methods for radiological examinations in this field are well codified. They have been covered by international agreements, and are satisfactory as a whole, although there are certain minor problems still to be overcome.

The same does not apply to our knowledge of the early signs of diseases like bronchitis and emphysema.

The epidemiological studies completed so far have shown that in this field clinical anamnesis if of little use in individual cases. The description of symptoms such as coughing, expectoration and dyspnoea cannot always be convincingly correlated with the objective methods of clinical and functional examinations.

The recent introduction of new methods for sensitive analysis of the mechanics of breathing, such as flow/volume curves and measurements closing volumes, have shown, too, that conventional spirometry can be faulty in quite a few cases of incipient bronchitis. Certain authors also claim that measurement of the CO transfer could be very valuable in such cases. On the other hand, it appears that functional effort studies, both bloodgas analysis and the tests to measure respiratory gas exchanges, only show deterioration some time after bronchitis has developed.

There is no doubt that our knowledge of these matters is still very imperfect and that a great deal of research will be necessary in order to pick out, from the many clinical and technical indications these functional tests provide, those that best predict the development of bronchitis.

From the point of view of industrial medicine, it is also important to study the applicability of examination methods in everyday practice. One of the most important aims of research must be to find ways of reconciling these needs, and close cooperation between the research and industrial medicine sectors could be extremely fruitful.

As for research on the early symptoms of these diseases, there is no doubt that research of the prospective epidemiological type, together with intensive functional and clinical examinations of large groups of workers, will yield the most useful results. But fundamental research on the same topics may also be of interest, and projects of this kind could study precise anatomical, radiological and functional correlations in man. In some cases they might also include experiments on animals, for detailed information on particular anatomical points.

III. ASSESSMENT OF THE EXTENT OF DISABLEMENT RESULTING FROM CHRONIC RESPIRATORY DISEASES ALREADY CONTRACTED

The points made above about research on the early stages of these diseases applies equally to research on more advanced stages of disease. The research discussed above should, at the same time, help to improve our methods of distinguishing different stages of seriousness of bronchitis and emphysema and their complications.

Another particular aspect of respiratory disablement is the fact that it frequently has an effect on heart function. Here we are thinking, above all, of early diagnosis of the effects of lung disease on the right-hand cavities of the heart. Detailed information on this subject is needed, so that more appropriate compensation can be given to disabled persons who cannot be relocated, and those who cannot be fully re-integrated. This information would also be useful for partial relocation of workers who have contracted these diseases, to other jobs for which they may still be suited.

IV. THERAPEUTIC RESEARCH

Opportunities for treating pneumoconiosis were virtually non-existent before the discovery of P 2o4. We have already mentioned above that although this substance is essentially for prevention of silicosis, it would be worth studying its possible stabilizing effect on extensive evolutive pneumoconiosis.

This is an instance of the use of the product for curative purposes; no major research project on this topic, with human subjects, has yet been carried out.

The treatments currently available for bronchitis and emphysema mostly affect only acute growths, reducing their duration and seriousness, and can thus prevent the appearance of serious complications with major repercussions on heart and lung functions.

One exception here is spastic bronchial disease of some types, resulting from specific hypersensitivity; in such cases, anti-allergic treatments will give better results.

Certain tenacious types of bronchitis that have recently appeared may well respond to good drug treatments of the anti-infectious, bronchodilatant and expectorant types, so that, in the medium term at least, they do not develop into chronic bronchitis.

This fully justifies all the research aimed at improving our means of controlling these diseases. We must therefore support and encourage all projects aimed at obtaining a better understanding of the indications for, and the effects of, anti-infectious drugs, as well as research for more specific information on the indications and effects of the many bronchodilatants new being developed, and on methods of improving bronchial drainage by physiotherapy or drug treatment.

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V. CONCLUSIONS

The remarks made above have shown that in this field research could usefully follow many different lines.

In conclusion, however, we may justifiably stress that particular priority should be given to research projects on the prevention of chronic respiratory diseases in workers, both those aimed at identifying the toxic pollutants responsible for the diseases, or determining the harmfulness of these pollutants and their effects on the respiratory system, and those aimed at improving our knowledge of ways of stimulating the normal defence mechanisms of the organism *vis-à-vis* toxic agents in working and everyday life.

A research policy of this kind would be fundamentally and closely in agreement with the aims pursued by the Commission in promoting programmes of medical research on health of workers in the coal and steel sectors.

DISCUSSION

Dr Grieco

I have two comments to make :

- The first is about the attempt mentioned by Dr Minette this morning to prevent pneumoconiosis by using P2o4. At the industrial health clinic in Milan, we have spent a lot of time discussing this problem and opinions are still divided about the advisability of using this product and of the usefulness of further research into it. I personally consider attempts at prevention rather than treatment to be neither moral, professional nor sensible. I should like the European Communities to investigate this problem more thouroughly and to oppose officially a continued subsidy for this type of research.

- My second comment is related to what I said yesterday and I should like to hear Dr Minette's opinion. I feel that it is essential, for the investigation of chronic bronchitis and its prevention, to carry out research into the part played by heat stress and differences in temperature in the working environment, particularly in foundries and steel works in setting off this disorder. We cannot prevent chronic bronchitis simply by studying inhaled pollutants and dust and smoke absorption. Thank you.

Dr Minette

The question of P2o4 is certainly very difficult and very controversial. You have expressed a very definite opinion and in many ways I agree with you. However, if people agree to undergo long-term preventive treatment which is known to be harmless, I do not know whether one can say then that it is immoral carry out this sort of experiment. Nevertheless, on the basis of simple good sense, I entirely agree, particularly as far as coal miners are concerned. These tests would have to be continued over a period of at least twenty years and it would be clear from the outset that, at the end of this period, none of the workers involved in this preventive treatment would be available. I think many people would therefore agree that this is a practical impossibility for the time being.

Turning to chronic bronchitis, I think Professor Sadoul answered your question yesterday. It is clear that heat stress is a particular problem in foundries and steel works. It also occurs to some extent in coal mines but is perhaps spread more evenly over the working day while, in your case, there are peak periods which should be investigated. I entirely agree with you here.

Prof. Voisin

I was extremely interested in Dr Minette's excellent report because he pinpointed research necessary for the prevention of respiratory diseases in the working environment. He quite rightly emphasized the need to know more about the aggressive agents and to minimize them, but there is also the question of individual receptivity. It is well known amongst industrial doctors that workers are not all equally susceptible to the hazards of their work, whether we are discussing the inhaling of dust or exposure to toxic gases. This is an important field of research; we are already familiar with some of the elements which determine the sensitivity of some workers to the risk of attack from airborne agents. This is the kind of research which should be carried out and, without being idealistic, we can hope to be able to guide industrial doctors in the years to come so that they can prevent the most sensitive subjects being placed in the most hazardous workplaces. I should like Dr Minette's opinion on this subject.

Dr Minette

You have just clarified the point I emphasized about the need to transfer sensitive subjects in time, either at the first sign of disorder, or even possibly before signs appear, that is to say, when their constitutional susceptibility to bronchitis and emphysema has been diagnosed. We must now try to go beyond the present limits of this type of preventive medicine in terms of both early-detection methods and analysis of susceptibility factors in exposed subjects.

I agree entirely with this.

Dr Rogan

I should like to make a general observation. I am sure that individual studies of hypersensitivity are important and useful but I am categorically opposed to the idea that the industrial doctor cannot have any influence over air pollution at work. Any industrial doctor worthy of the name should, in conjunction with his colleagues, the industrial hygienists, know exactly or very nearly, what pollutants there are in his enterprise and whether they are likely to affect the staff. He should insist on the menagement ensuring that these hazards are eliminated and, failing this, he should report to the boeard of directors. If they do nothing, the unions will sooner or later compel them to act.

Prof. Worth

Dr Minette has rightly emphasized the importance of the early detection of pneumoconiosis and non-specific respiratory disorders. However, detection methods differ greatly in the two categories of disorder. On the whole, radiological diagnosis of pneumoconiosis is carried out with extreme precision, but this does not apply to the tracking down of early symptoms of chronic non-specific respiratory disorders.

In future, emphasis should be put on improving the early detection of these non-specific disorders. There are two alternatives: either industrial doctors' consulting rooms must be better equipped for functional analysis or, in certain regions, there must be a centre with the appropriate equipment. At the moment not enough attention is being given to non-specific disorders.

My second proposal is this : coughing and expectoration are symptoms which can reveal very different clinical pictures. These symptoms can be totally benign - a defence mechanism - but they can also betray an irreversible obstructive lesion of the respiratory tract. I therefore consider that, in future, we should be more specific in investigating these respiratory disorders and the precise significance of coughing and expectoration. Otherwise, we might fail to distinguish between symptoms which are in fact manifestations of totally different diseases.

Dr Hentz

I should like to ask Dr Minette to clarify his thoughts on methods of stimulating individual defence mechanisms - he has carried out vaccinations, if I remember correctly. Very briefly, what were the results? Were they positive ? Does any other industrial doctor at this meeting have anything to say about this? What vaccinations have already been carried out and what are the conclusions?

Dr Minette

You mentioned the tests we carried out as part of the last programme which had two objectives. The first was to study the effects of influenza vaccination on absenteeism through respiratory disorders in the winter. This was a large-scale investigation, during which all the workers at a colliery were vaccinated - these amounted to 5,000, as far as I can remember. Half of these were injected using a placebo and the other half using the influenza vaccine. The results were not absolutely conclusive in that they did not confirm that the influenza vaccine had helped to prevent acute respiratory disorders during the winter, but nevertheless, in absolute figures, there were more immune subjects among those actually vaccinated than among those vaccinated by means of a placebo. The difference was, however, not significant.

But this first test carried out with the cooperation of all the medical services of the colliery also suffered from a second drawback. It is extremely difficult to establish valid and reproduciable criteria to show what winter respiratory morbidity actually consists of. Our criteria were obviously rather vague and the various doctors responsible for checking results of the tests clearly did not make the same kind of evaluation. Nevertheless, we are left with the impression that this sort of influenza vaccination is useful. This is a clinical impression and we hope to do another test in the future with a firmer basis.

We also carried out restricted tests with general polymicrobial vaccines of the CCB type and with the same type of vaccine using peroral administration. These were clinical tests, but we have never carried them out as strictly controlled experiments with treated and non-treated subjects. The efficiency of these vaccines is disputed, particularly by bacteriologists, but I personally still feel that they are useful as long as they are given to subjects likely to benefit from this sort of stimulation. There is no point in trying them on subjects who have already reached an advanced stage with considerable suppuration : logic and good sense indicate that it is too late to vaccinate these people. However, as a practising doctor I am sure that this sort of vaccination is beneficial to sufferers in the early stages of chronic bronchitis (slight secretion, mild chronic bronchitis) who are not yet seriously ill.

THE WORK AND FINDINGS OF THE WORKING PARTY ON INDUSTRIAL MEDICAL SERVICES

Dr. J. GODART, Paris

In Article 55 of the Treaty establishing the European Coal and Steel Community, the authors of the Treaty entrusted the High Authority with the task of initiating and encouraging research in the field of occupational health, hygiene and safety, thus displaying a remarkable broadness of outlook and, in this field as in many others, a keen understanding of contemporary problems.

It is not for me to describe in this brief report the ways and means used, the difficulties encountered or the results achieved. Even so, I feel I must at least mention that as from 1956 an undeniable impetus has been given by the ECSC and later the Commission of the EC; fruitful exchanges of ideas between institutes, research workers and industrial concerns at European level have been achieved, many projects have been successfully concluded and others are under way.

We need only mention, for those who are not familiar with our work, cardiorespiratory physiopathology, pneumoconiosis and its diagnosis by radiology, dust and dust measurement, carbon-monoxide poisoning, noise, heat, burns, cranial traumatisms, rehabilitation, human factors and safety, all of which, along with other subjects, have been dealt with both in fundamental research and in practice for some twenty years, thanks to the Community, its directives and also - why not emphasize it - its subsidies. Yesterday's session was yet another excellent example of this.

But it had not escaped the attention of those who had set in motion the apparently intricate machinery of the European structure that this ought to include provisions for constant collaboration between research workers and practitioners, between scientific institutes (more often than not universities) on one side and on the other those who are, as they say, on the spot, i.e. in permanent contact with the labour force of the enterprises concerned; and to the force in this second group are the industrial medical officers.

This is the spirit which led to the setting up in 1956 of the working party on 'practical information for industrial medical officers' which has been very active from the start, thanks in particular to the efforts of Prof. Mossinger, Director-General Convenevole and Dr Claass.

The very title of this working party was, however, slightly ambiguous. What did 'practical information for industrial medical officers' mean exactly? Was it only the members of that party who were to be informed of work carried out elsewhere within the ECSC? Were they to pass on this information to all the medical officers in our industry and, if so, how? Was its purpose to carry out some appropriate research in keeping with the specific qualifications of its members?

No precise definition was ever obtained. All things considered, that is not so important; we might even go so far as to say so much the better, for all those aspects were involved at the same time, and this permitted great variety and freedom in the choice of subjects dealt with and methods used. What matters is that the contribution made by those who felt they represented industrial medical officers in some way inside the Community structures was important and, to my mind,useful.

The activities of this working party were somewhat slowed down around 1968 by the re-shaping of the European institutions, but they returned to normal in 197o under Dr Vidali and Dr Hentz.

Henceforth called the 'working party on medical services in the coal and steel industries', its task was more clearly set out and can be defined as follows :

1 - to inform the higher authorities of the Community of the practical problems encountered by medical officers in the coal and steel industries in the fields of their competence;

2 - to answer requests for information in these fields from the same authorities;

3 - to carry out a detailed examination of the activity of the industrial medical services by comparing experience, studies and appropriate research;

4 - to participate in information campaigns intented for medical officers as well as the employers and employees of our industries.

I can add that when the need has arisen the working party has not failled to act as a deliberative body, venturing to make observations on the future on the basis of the long practical experience acquired by all its members.

Within this framework, a large number of subjects has figured on its agendas over the past four years. It was not easy for the working party to choose the ones more likely to be of equal interest to those present at today's symposium, whatever their speciality and social or professional origin.

We have chosen the ones which we think admit of clear conclusions in spite of their complexity, and which can be explained within the time limit imposed upon each of the rapporteurs.

On the other hand, we decided to omit other subjects, although they have been studied in detail, because our ideas on them are not yet sufficiently clear, which is not really surprising considering the differences in our respective origins, our education, and the sociocultural context and the administrative and legal framework in which we work. I need only add that the habit we have acquired of working together, the friendship and mutual understanding which bind us - which have bound some of us for more than twenty years already - partly compensated for these differences.
Nevertheless, among those subjects still being studied, there are two which deserve to be mentioned. They are good examples of the difficulties we have come up against and of the care that must be taken in formulating solidly buttressed conclusions.

Vertebral pathology, especially in the context of the sacro-lumbar region, is a major cause of absence from work and disability in the coal and steel industries. Some industrial medical services have for a long time been carrying out systematic pre-employment radiological examinations of the vertebral column. And for a long time, too, most industrial medical officers have been struck by the frequent discordance between anomalies revealed by radiological examination and the large number of clinical and functional ailments felt or alleged; hence the differing opinions of the medical officers as regards fitness for work. This eminently uncomfortable position prompted the working party to concentrate on the matter, consulting qualified specialists and studying a great amount of international documentation.

Nevertheless, the somewhat divergent opinions of the members of the working party - we could in fact call it the clinical tendency vs. the radiological tendency - the scarcity of work carried out scientifically in this field and of reliable statistics on the relation between the frequency of vertebral pathology and working conditions (postures, strains, environment, etc.) have called for extreme caution.

The importance of clinical examinations, the role of vibrations, the influence of rheumatic ailments, the significance of muscular contracture as the source of pain from the clinical point of view, recourse to movement training and to ergonomics in matters of prevention, the dangers of being overselective while using uncertain criteria and also the creation of compensation neurosis in suggestible subjects have all been alluded to.

Other questions:

When should radiological examinations be carried out and how frequently? And on whom? On all new workers or only on those to be assigned to high-risk jobs? And which are the high-risk jobs?

Which radiological technique should be used, and in carrying out radiography systematically is there not the risk of contravening certain provisions or recommendations on the limitation of radiation?

The above points are still unclear. It was therefore decided to fill in the gaps in the working party's knowledge :

- by asking other specialists to come and give their points of view;
- by asking the members of the working party themselves to collect as much information as possible within their own departments;
- to note relevant publications, studies and works they consider worthy of interest;
- to gather, if necessary, the opinions of colleagues aware of the problem, using a common method of survey.

The second, very **revealing**, example is the question of the use of <u>data-processing in industrial medicine</u> which has also been discussed on a number of occasions. This was inevitable, as the subject is of current interest and many attempts at practical application have been made in different places in the most varied conditions.

The working party soon realized that data-processing, which must not be confused with, for example, machine methods of classification, will be an invaluable instrument of work in the future in all branches of medical science and hence in industrial medicine, but that its progressive application must, if it is to be successful, fulfil a certain number of conditions : the objectives must be limited, there must be complete understanding between data-processing experts and medical officers with a view to meticulous programming; management must be regularly informed so that it can evaluate the cost/services received ratio; and finally the workers' representatives must be kept informed in order to set their minds at rest about the human aspects of data-processing, real objectives, medical secrecy, etc.

The members of the working party also thought that the use of data-processing in industrial medicine should, at least at the beginning, be used :

a) in epidemiological surveys on nuisances and their correlation with health, and to study occupational diseases and toxicology;

b) to run the labour force on a qualitative basis and assign workers to tasks which best match their aptitude.

Moreover, there are two big snares which could be prejudicial to the system or even cause it to be abandoned.

The first would be to attach almost exclusive importance to factors which can be qualified to the detriment of those which cannot be measured : the personal ambitions of the workers, will and goodwill, the psychological climate of the enterprise and the factory, in a word, everything which constitutes one of the essential aspects of working relations.

The second is that the computer can store and restore only what is fed in to it. If the basic data are incorrect or incomplete, the results could be catastrophic. Without going to that extreme, it must be emphasised that to obtain positive results from data-processing, a considerable effort must be made to formulate precise ideas and to adapt to a new and common language, which is in opposition to habits quite deep-ly-rooted in the medical profession. It goes without saying that if data are required at international level, the diversity of the terminologies used complicates matters even further as experiences has shown us on several occassions. That is why the working party, after careful consideration and study of the methods and results of experiments already carried out in this field by different enterprises within the Community, has considered it premature to advocate immediately specific applications or particular data-processing techniques. It therefore whishes to keep track of new experiments, of their successes, difficulties or failures, before making snap suggestions of a general nature.

The two examples which I have merely outlined clearly show the complex nature of the problems industrial medicine faces today.

We must not forget that industrial medicine is based on traumatology on the one hand and toxicology on the other. Apart from a few rare and brilliant exceptions, it was the middle of this century before the industrial medical officer made his appearance at the place of work and before the organization of medical services within industry came to be considered, as a former director general of the ILO, Mr Wilfred Jenks, put it, the cornerstone of any rational policy aimed at promoting the physical well-being of workers. The ILO - WHO recommendation of 1950 was the first international instrument representing this standpoint; it was followed in 1962 by the recommendation of the Commission of the EC to Member States.

But it is noteworthy that the first regulations on the subject adopted somewhat different approaches according to the underlying tendencies of each of the countries concerned. Whereas the United Kingdom, for example, placed the emphasis on industrial hygiene, France put medical examinations of the labour force before all else. This is no cause for surprise if we bear in mind that the United Kingdom has always been in the forefront of research into epidemiology and biological statistics, and that the first studies on the adaptation of man to work by Vernon,Greenwood, Newbold,and many others appeared as long ago as 1917, and that it was in this country that the term and the concept "ergonomics" came into being. And this in spite of the fact that French medicine distinguished itself throughout the 19th century thanks to the excellence of its clinical school.

Other examples could no doubt be given to explain the differences between the respective legislations and the implementing procedures concerning industrial medicine in Member States. But beneath the socio-cultural variations, we must look for the basic constants and, more important, the common features which will enable us to align points of view and, by extension, the institutions based on them.

For, in spite of its brief existence, industrial medicine has already evolved considerably, like medical science itself, like our lives, like our Europe.

Although almost unanimously recognized as being useful, there is some difficulty in fitting industrial medicine into the different structures of curative and social medicine, and in determining what role it should play. Several of its original goals on which the emphasis had rightly been placed in the years following the Second World War, e.g. the detection of tubercolosis, no longer have the same importance and to maintain routine techniques might detract from the real significance of industrial medicine, in which so many hopes have been placed.

If key-words were required to describe the future course industrial medicine should take, the most appropriate would propably by specific and interdisciplinary. The industrial medical officer cannot remain isolated in a sort of ivory tower within the enterprise. The problems which concern him are increasingly related to those facing other technicians at a time when the basic structures of the enterprise and working conditions are themselves being questioned.

As former Chairman of the working party, these are some of the brief reflections I felt I ought to put before you at the start of today's symposium which I hope will lead to fruitful exchanges of ideas and help to consolidate contacts, not only between the medical officers of our industries and with research scientists, but also between them and both sides of industry.

DISCUSSION

Dr Foehr

We should like to thank Dr Godard for his excellent report. I am sure that the success of the Working Party on Industrial Medical Services is due very largely to Dr Godard who has been such an excellent and dynamic chairman for the last few years. We all hope to be able to continue drawing on his experience in future even though the regulations require that, officially at least, he now retires from our Working Party.

We now have ten minutes for discussion.

Professor Gimenez

I should like to ask Dr Minette whether it would not be a good idea to examine the upper respiratory tracts of workers exposed to dust. We spoke just now of the variety of responses from subjects exposed to dust and we are familiar with the part played by the nose filter. Have there been any systematic examinations of the upper respiratory tract and, if so, what were the results?

Dr Minette

As far as I know, this sort of survey has never been carried out systematically, but it would indeed be very useful.

Dr Vidali

I personally found Dr Godard's report on this work very interesting. A few years ago, when we re-formed this Working Party, we provided it with a chairman and a certain amount of autonomy. We expected that the Working Party would tackle a number of problems on its own initiative, and this is what has happened. Today we are going to discuss some of the problems examined. I was very interested to hear what Dr Godard had to say about certain problems of industrial medicine in relation to data processing i.e. the processing of medical data within the enterprise itself. I understand very well that doctors are reluctant to make a hasty decision about the stand they should take on the subject as a whole. I feel, however, that in some fields rapid progress is desirable. Let us not forget that the solution to some of the problems we have discussed the early detection of respiratory diseases, for example presupposes the carrying out of epidemiological research within the enterprise(which means that the medical service of the enterprise must take the initiative) and the availability of comparable data. Thus, the epidemiological surveys which have been mentioned, concerning harmful substances and their correlation with health are a first step towards the agreements, at least working agreements, which we must reach as soon as possible if longitudinal surveys, i.e. really ambitious surveys which can be spread over several years, are to be launched. Yesterday evening we heard Dr Muir's report on much simples problems, such as pneumoconiosis in coal miners, which is studied in the United Kingdom over far longer periods of time than anything we have been able to carry out up to now. When a system of medical documentation is created for continuous practical use, it must be designed in such a way that it can be made permanent if necessary. In other words it must be very carefully prepared and thought out. These problems cannot wait indefinitely and a solution must be found very quickly if we are going to make any practical progress. Thank you.

Mr Rota

I too should like to express my appreciation of Dr Godard's paper, and particularly of the way in which it is set out. I think we must all bear in mind the differences which exist between our countries. In Italy, however, we have since 1970 had legislation known as the 'Charter of Workers' Rights' which allows workers to play an active part in industrial medicine and the enterprise and at the same time makes them aware of their privileges. The idea behind this is to create a system of public industrial medical services known as industrial environmental services, which are subsidized by the state or local authorities and are avaible both to the enterprise and to the workers. In recent years, particularly during the last four or five years, about 5o centres for industrial environmental medicine have been set up in various regions, particularly the most industrialized regions. Turning to data processing, the information collected should not simply be used as a service to workers. Workers themselves should be able to help in collecting the information and storing it. Thank you.

Professor Bollinelli

I was also very interested in Dr Godard's report and the problems raised in connection with trends in industrial medicine. I should like to mention three important points. The first is data processing. I feel that industrial doctors have no time to lose and that computer processing of data, with a view to their subsequent use, should be given high priority, assuming of course that medical ethics are not abused. My second point is the merging of industrial valuable medicine with public health as a whole: it is ridiculous that information collected by industrial medical services, which are in the best position to observe the individual throughout his active life, should be lost to medicine in general. I think that industrial medicine has a privileged if not fundamental place in the field of preventive medicine. My third point is that developments in industrial medicine should take place in close conjunction with universities: I personally should like to see departments of social and community medicine where industrial medicine would be closely associated with other types of preventive and social medicine, whilst at the same time retaining its own specific identity - a condition which is essential.

Dr Foehr

I should now like to give the floor to Dr Mellis.

INDUSTRIAL MEDICINE AS SEEN BY THE ENTERPRISE

Dr. L. MELIS, Cagliari

It is a common belief, especially in non-medical circles, that occupational medicine is a young science and therefore none too trustworthy.

Nothing could be more untrue; even Hippocrates, the father of medicine, was interested in the problem of occupational diseases and working conditions which affected the workers of his time. Men like Paracelsus and Ramazzini and many others dedicated their lives to these problems.

The truth is that industrialization and the resulting rapid technological progress have led to a growing and disorderly host of new problems, new realities and new environmental situations to be faced.

We should like to acknowledge the numerous and essential contributions to research into problems concerning especially prevention and rehabilitation made - in Europe; also with the financial help of the Community - by many scholars and the university schools of occupational medicine.

Occupational medicine, even in its fields of practical application, is therefore a well-established science with roots in Antiquity, but was for a long time misunderstood and even opposed.

It is not possible to apply special labels to this branch of learning, which is concerned with the health and well-being of workers, or to consider it from contrasting standpoints although these unfortunately exist within our changing society, where they are being lent increasingly vocal expression as workers become more aware of the lack of congeniality of their environmental conditions.

To talk of standpoints, or indeed of their very existence, is all the more harmful inasmuch as it gives rise to ambiguous and conflicting situations which distort and often shatter what is in fact the true image of a science whose only aim is to safeguard the physical and psychological integrity of the worker.

These premisses must be taken into account if the enterprise wishes to set up a reliable and efficient medical service, dedicated essentially to prevention, of diseases caused by the work environment, and also of industrial accidents, as the key to occupational safety.

In any undertaking prevention and safety should constitute the foundations of this service, which is an expression of one of the highest social and human achievements.

Of course,an agreement between the two sides of industry on the management and running of industrial medical services is difficult to reach; and this is unfortunately where differences of opinion arise.

There is a clash of conflicting interests and the different motivations and concerns soon form a complicated and ambiguous labyrinth.

This state of conflict obviously creates distances and gaps which must be birdget if they are not to have negative repercussions on the work of the industrial medical officer, who personifies the medical service and Occupational Medicine in the enterprise.

The company must ask itself just how far it will agree and wishes to go in setting-up of a medical service, over and above what must be provided to meet legal requirements. And the workers also should face up to the same question. Somewhere, in between the management and the workers - the two main interested parties - one finds the industrial medical officer. In his professional capacity, he should not be subject to constraints in his work, but should enjoy a freedom of movement enabling him to act as an unbiased consultant, rather than as a key figure - the servant only of his science, which he should expound with the utmost integrity.

This idealized image is somewhat of a myth, but at the same time it is the only guarantee of impartiality between two opposing parties attempting, for different reasons, to monopolize a branch of learning. One side tends - perhaps involuntarily - to regard the industrial medical service as a repressive fiscal measure, while the other side sees it as an instrument of the employers.

These conflicting views are the source of misunderstandings which are more often than not irremediable and result in violent contrasts hindering real progress which would, all things considered, be to the advantage of both sides.

I insist that occupational medicine cannot be split up to make two kinds, one for the employers and another for the employees. Occupational medicine is one single reality which should be jointly managed so as to guarantee complete moral and professional independence for the medical staff who go about their duties in full awareness of their responsibilities.

There are very valid reasons behind the permanent and persistent dissidence of the workers. A growing awareness of occupational health questions and of hazards previously unknown,the rejection of the principle of danger-money and, increasingly urgent calls for risks to be eliminated or at least reduced are some of the arguments which have been brought forward with conviction and determination.

It marks a further stage in the evolution of an attitude which arose approximately in the fourteenth century with the setting-up by workers in Germany of the 'associations of miners' and in France of the 'Confraternité' in order to protect their interests. This attitude is now giving rise to increasingly frequent open drives by workers for self-management, which are the result of old, firmly-established and mistaken beliefs, resulting from the work systems of the past.

In his brilliant paper on this subject, Dr. Cordier neatly summarizes what I am trying to explain, in two sentences setting forth the pre-requisites of a good and efficient industrial medical service :

1. technical and moral independence of the medical officer in relation to the enterprise and the workers;
2. the need to dispense the medical service from policing duties.

To what Dr. Cordier has to say I should like to add that one of the industrial medical officer's tasks is to make people aware and convince them of the need for certain measures.

As far as safety, preventive medicine and health education in the broadest sense are concerned, rules and regulations are not really valid unless everyone at all levels within the company is fully aware of the problem.

Effective prevention can be achieved only where the management is aware of the problems which exist and acts responsibly. As I said a few moments ago, one of the medical officer's tasks is to create this awareness; both sides, being sure of obtaining undeniable advantages, should support him without reservations.

Suggestions, advice and recommendations, even if they are not confirmed by clear-cut legal provisions, should be accepted and above all applied, in the same way as one accepts and abides by a lawyer's advice.

This calls to mind the fact that whereas every enterprise has a sizable legal organization, an efficient medical service is often lacking.

All this is food for thought and prompts us to ask questions which leave us at a loss. Huge sums of money are sunk into project and research bureaus in enterprises in which, for example the need for an ergonomic team to collaborate with design engineers in building factories more consistant with health and hygienic requirements is not recognized.

The same enterprise may later be compelled to introduce more expensive and sometimes not very effective changes in order, for example to eliminate or reduce the noise level at the place of work.

The enterprise often attaches great importance to curative medicine and health insurance schemes, neither of which has anything to do with the industrial medical service. Curative medicine is something quite different and is entrusted to the competent boards and doctors.

Even so, there has to be sound and close cooperation between curative medicine and occupational medicine, but this is another matter too long to consider here and which exceeds the scope of this report.

Simply from the point of view from the effort and will involved, it is far easier to equip an enterprise with surgeries and provide resident medical teams than it is to organize a comprehensive medical service including, for example, the registration of the biostatistical and environmental data, personal medical files and in short everything necessary to give the worker all-round health protection.

As to what an industrial medical service should be and on what it should be based suitable definitions must first be given for those working conditions generally conceived of as harmful, arduous and unpleasant.

Harmful conditions stem from the presence in a working environment or at workplace of factors which, individually or in combination, can give rise to statistically significant impairments, in the biological integrity of anyone remaining there for a relatively standard time (8 hours a day, 5 days a week, throughout his working life), impairments which cannot be reversed in the breaks between periods of work.

Arduous conditions are those in which the work entails an expenditure of energy exceeding the physiological recovery rate; this means that a worker assigned to a specific arduous task needs an adequate period of rest before being able to continue with that same task, and shows evidence of physical and/or mental strain.

Unpleasant conditions ensue from certain effects of working environments and technologies or of relationships with others at work, which engender a particular state of physical and/or mental distress in a worker.

The study of the factors which determine health and safety hazards, and/or the unsuitability of a particular working environment or work situation, involves collecting information not only on physical parameters (environment, technology, state of health), but also on psychological parameters, which are often underrated.

Research carried out to establish whether harmful, arduous or unpleasant conditions exist in particular places of work must be integrated and must take into account the objective, measurable factors which an examination of the worker and his environment reveals, as well as the elements of a subjective nature corresponding to the everyday experience of the work situation on a rational and emotional level as gained by the individual worker and as reported by the group concerned. Group participation must be secured throughout the research at production unit, department and workplace level.

In order to gain an accurate firsthand picture, trace developments, draw comparisons and obtain clear-cut information, it is necessary to initiate and develop a scientific methodology which could proceed as follows :

- the definition of the single parameters into which the

phenomena under study can be broken down;
- their codification in quantitative or, failing that, qualitative symbols;
- the statistical treatment of data by means of structural analyses (which enable us to identify cause and effect);
- the interpretation of the results according to their meaning : medical, physiological and technological.

EXPLORATORY OUTLINE OF WORKING CONDITIONS

The various stages of research in identifying harmful factors at workplaces are as follows :

a) description of the work ;

b) environmental data ;

c) ascertainment of the compatibility of work with health.

a) Description of the work

The elements necessary for at least a preliminary identification of the characteristics of the work in relation to the physical and mental stress (fatigue, overburding, complexity, monotony, potential dangerous or unpleasant factors) can be outlined in the following points :

- location of the place of work ;
- timetable ;
- position of the body ;
- physical effort;
- mental stress;
- the most conspicuous unfavourable elements;
- specific risks already known.

b) <u>Environmental data</u>

The physical and chemical parameters relating to environmental hygiene at the workplace are as follows :

- microclimate (temperature, radiant heat, humidity, ventilation, change of air);
- noise, vibration, (possibly) changes in atmospheric pressure;
- lighting at the place of work;
- pollution (dust, gas, smoke, fumes, etc).

c) <u>Ascertainment of the compatibility of work with health</u>

The collection, elaboration and interpretation of this series of data is the most important and complex part.

To be complete, this series must include the following items of research :

- <u>biostatistical survey</u>

a) absences caused by illness (frequency, seriousness, morbitity rate);

b) occupational accidents and diseases or those connected with the working environment;

c) turnover, with special reference to changes of employment for reasons of health.

- <u>clinical survey</u>

a) health records complete with all necessary supplementary surveys;

b) study of the morale and attitudes of the workers in the group concerned.

The solutions for implementing the whole programme that has just been outlined are as follows :

- consultation of :

1) university institutes, in order of priority;

2) independent consultant doctors and psychologists specialized in the field of occupational medicine, and at an expert in the statistical treatment of complex data;

3) private institutions;

4) employees willing to collaborate.

- mixed solutions

The records to be kept are as follows:

a) register of environmental data;

b) register of biostatistical data;

c) individual health records and risks files;

d) individual clinical case history.

<u>The register of environmental data</u> collects information from:

- group questionnaires;
- surveys of physico-chemical parameters;
- analysis of work, if necessary.

<u>The register of biostatistical data</u> collects information from or re :

- group questionnaires;
- clinical records;
- absences caused by illness;
- industrial accidents;
- turnover of employees.

The <u>health risk file</u> contains details of :

- exposure to risks which existed previously;

- exposure to occupational hazards which exist now, as obtained from the registers of environmental data and the work analysis;
- physiological family medical history;
- occupational medical history;
- examinations : objective, instrumental and laboratory (if possible as from the date of employment) to include all subsequent periodical examinations;
- clinical summary of conformed pathological states;
- indication of the risks that harmful environmental factors may aggravate pre-existing handicaps;
- space reserved for the attending doctor's diagnoses.

The individual clinical record contains data related to each worker, collected by doctors or by laboratory and instrumental examinations, including any therapy carried out.

For the implementation of the programme, the following stages should be envisaged :

1. Identification and establishment of the "homogeneous groups", each of which comprises all the workers who collectively consider that they belong to an environmentally and technologically similar situation;
2. Elaboration and distribution of a group questionnaire;
3. Establishment of the type of environment and the locations at which it is to be measured;
4. Establishment of the type and of the frequency of the medical checks;
5. Possibly analysis of the work from the psycho-physiological point of view (this analysis must obviously be extended over a considerable period owing to its complexity);
6. Preparation of the register of environmental data.

The technical management of the results should be subdivided as follows :

1. Individual report of their personal clinical situation to the persons concerned;
2. Informative treatment of the data;
3. Clear presentation in plain language of hazardous harmful and otherwise unsatisfactory situations to the production management and to the workers;
4. Introducation of all necessary corrective and preventive measures, also at planning level.

DISCUSSION

Dr Foehr

I would like to thank Dr Melis for showing us how complex and important the industrial medical officer's duties are in a modern enterprise. There will no doubt be many questions on this subject. Who would like to speak on this paper?

Dr Craviotto

Mr Chairman, as the title of the paper is 'Industrial medicine as seen by the enterprise', I would like to ask two specific but constructive questions.

First of all, is the point of view expressed by Dr Melis that of the enterprise or that of a doctor aware of the problems and conditions which exist within an enterprise? It if its the first, then we would have to admit that a change has taken place over recent decades. If it is the second, we might also think that a change has taken place, but that we are perhaps still far from the real state of things.

Furthermore, in the second part of Dr Melis' paper, the practical section which deals with some summarized extracts from work contracts or social laws, a large number of verbs are in the conditional tense. My own view is that the report does not go to the heart of the matter. How many of the extracts mentioned are in fact requests and how far do the enterprises comply with these requests?

Dr Foehr

Are there any more questions? Dr Melis can answer all the questions together.

Mr Chauveau

Mr Chairman, I think I ought first to thank the Directorate "Safety and industrial medicine' for including the problem of industrial medical officers on the agenda of this symposium. Its structure is not at present very sound, but industrial medicine is nevertheless very important in the context of hygiene and working conditions. Our only regret is that a paper on industrial medicine as seen by the workers was not included on the agenda, a regret which was, moreover, expressed at the Symposium on dust control, and not by a trade union representative, but by the manager of a very large French coal field. According to Dr Melis, it is a mistake to have a specific standpoint. We are not of the same opinion. As Montesquieu put it so well, every individual placed in a position of authority tends to exaggerate and unless authority is granted to another person, whether an engineer or a doctor in this case, in order to restore the balance, problems will remain unsolved. Besides, a report drawn up by a worker would not have been very long. We must consider the situation as it stands at present. When workers are asked about the industrial medical officer, this is what they answer : 'I only saw him at the pre-employment medical examination' or ' when I was injured' or 'I have never seen him below ground'. Another answer is that given by the sick or injured worker who sees the industrial medical officer arriving after being briefed by the Personnel Officer with a view to a quick return to work. Obviously, this situation varies considerably according to the social climate regning within the enterprise, but it is a situation which often arises. And, of course, the reaction is almost instinctive! As for the workers' delegates and the representatives of the Safety Committee, they are certainly better acquainted with the industrial medical officers. Their impression, however, is that the latter are not sufficiently independent of the management, which always tends to cover up irregularities, and that they are slow in providing them with information which could help them reach a judgment on improvement, on hygiene and on safety, particularly with regard to statistics. This can have far-reaching consequences. For example. I am a member of the Mines Safety and Health Commission. This Commission's annual reports always contain a chapter on industrial accidents, but there are never any statistics on silicosis and industrial diseases. Consequently, a large number of problems remain concerning the practice of industrial medicine. These problems led some time ago in France to long discussions between both sides of industry on the subject of working conditions. I can only give you the result which in fact represents a compromise, because there was stiff opposition on this issue on the employers' side. You must forgive me for quoting a text here, but it reflects very well the main concern which dominated this part of the agenda : 'Industrial medical officers have an indispensable role to play in matters of hygiene and safety, especially with regard to everything concerning the compatibility of work and worker. Their opinions must be heard by all the authorities responsible for safety and working conditions. Both managers and those in charge of inter-enterprise medical services should do all they can to help them fulfil the tasks entrusted to them in this context and allow them the time necessary to perform their duties, especially with regard to inspection of installations. Attention is drawn to the fact that the management must provide the industrial medical officer with details of products used in the factory and their composition, and that he must be consulted whenever a new production technique is being worked out and kept informed of modifications made to machinery and equipment'.

Dr Amoudru

In view of what the last speaker has just said I would like to make one point clear. Altough Mr Chauveau represents an important workers' organization, I do not think that his information on industrial medicine is recent, insofar as in the coal mining sector and throughout French industry, workers have an annual medical examination. It is therefore incorrect to state the industrial medical officer is seen only at the time of the pre-employment medical examination or when an accident occurs. So firstly he has got his facts wrong. Secondly, medical officers do go below ground and do visit work sites. Dr Michot, who is here today and is chief medical officer of the coalfield you refer to, can easily tell you how many visits below ground our doctors have made this year.

I was anxious to make this quite clear so that there be no incorrect information concerning industrial medicine in the coal mines of France. It is the object of sufficient censure as it is, so let us avoid adding factual errors to legitimate criticisms. Thank you.

Dr Vidali

I think that an omission has been made in the presentation of our programme. We spoke about the activities of the Working Party of the ECSC Industrial Medicine Committee. We presented its activities, we spoke about its work, and then we listened to a series of papers. These papers do not represent the Working Party's official stand, especially as far as the paper which has just been given is concerned. This is a personal communication by Dr Melis. It is not therefore an official communication by the Working Party and in particular is not the Commission's official position. On the contrary, some of the viewpoints which have just been expressed are in conflict with Community policy. On the subject of this policy, I refer to texts adopted by workers and management in the steel industry in which there are ten basic principles in the philosophy of prevention! According to these principles, a definite stand by the management of the enterprise first of all, and then by the workers, is desirable, among other things, on questions of prevention. I say this because Dr Melis has spoken of the medical officer as an unbiased consultant. In my view, we do not want anyone to remain unbiased when it comes to risks at work. We hope that management is aware of these risks and will outline its policy with regard to improvement of working conditions and prevention. We hope that both sides of industry will work together in order to achieve this prevention, and that the industrial medical officer will also be solidly and openly committed in this drive. It is clear that evaluations and judgments can vary from one side to the other. But when all are resolved to improve the situation together, I believe it is always possible to collaborate on a practical level. My opinion is that in this field we need independent consultants, but not unbiased consultants. Thank you, Mr Chairman.

Mrs Dr Stollenz

I am an industrial medical officer. I will be brief, as I know we are running out of time. I followed Dr Melis' explanations with great interest and I would like to thank him for his paper. He very clearly defined the aims of industrial medical officers and all those who take part in the research. We know that our scope is somewhat limited at the present time. This is due to the fact that it is not only a new field, but also to the fact that we do not yet have a sufficient number of people who are competent in this matter. What you said is also quite correct. It is not necessary to stress the fact that you also spoke on behalf of workers and industrial medical officers.

Dr Melis

I will be extremely brief as we are running late. I would, however, like to answer the various questions put to me and take the opportunity to thank all the speakers. My paper reflects any personal point of view as well, I am convinced, as that of a large number of industrial medical officers.

Obviously, I cannot interpret the point of view or the ideas of the enterprises. That is impossible. As for the second part of my paper, I do in fact use the conditional because, although it is true that action of this kind has been undertaken in a relatively comprehensive way in certain enterprises, unfortunately the subject has not even been broached yet in the majority of enterprises, especially in the small and medium-sized enterprises. By using the conditional tense, I reflect my desire to see this procedure followed in all enterprises.

THE TRAINING AND DUTIES OF PARAMEDICAL STAFF IN INDUSTRIAL MEDICINE

Dr. H. KNIEB, Bochum

The industrial medical officer, like any other doctor, is dependent on qualified staff. Without close cooperation between the medical officer and his assistants there would be no hope of finding a solution to the innumerable medical problems arising in an industrial undertaking.

With the growing independence of industrial medicine and an increasingly marked division between the various duties of the industrial medical officer, the need for trained non-medical assistants is also becoming increasingly urgent.

Industrial medicine was, and still is, by nature clinically orientated. Industrial medical officers who have gained their experience in hospitals, specialized and general practice, bring with them their own aims when they go into the field of industrial medicine. The qualified staff brought in as assistants have also been trained for the needs of hospitals and general practice. It is therefore hardly surprising that important organizational work on industrial physiology and hygiene is not given due attention. This tendency is aggravated by the outsider's idea of industrial medicine as a general medical service transferred to industry.

The "Industrial safety law" (ASiG), which came into force on 1 December 1974 marked a turning point. According to this law, the industrial medical officer's mandate requires him to concern himself primarily with the workplace and to observe, measure and analyse both working conditions and human behaviour under such conditions. He is expressely required to provide specialist advice on all matters pertaining to industrial organization, to both the employer and the works council. Further duties include organizing first aid, arranging in-service training for the assistants, examining and advising employees, documenting and analysing information and a large number of duties in the fields of general practice and social medicine not specifically mentioned in the law.

The professed aim of humanizing the industrial scene could not be attained unless certain conditions were met. Under the terms of sec. 2 of the Industrial Safety Law, the employer is obliged to provide industrial medical officers with'the necessary auxiliary staff, premises, equipment, instruments and supplies for the performance of their duties'. In view of the significance, scope and variety of the medical officers' duties, the term "auxiliary staff" as used in the law must be taken to mean a staff of well-trained specialists with the appropriate qualifications for their various functions.

These functions derive directly from the duties of the medical officers and fall into four broad categories:

1. Medical and clinical diagnosis and assistance in the medical officer's work
2. first aid and rescue work;
3. ergonomics and work organization;
4. administration and documentation.

   1) As the industrial medical officer's work mainly preventive it relates to the early detection of susceptibility and disturbances prior to illness. This necessitates the quikest possible identification of chemical, physical and other harmful substances arising from the working process, materials and environment. An accurate assessment of the employee's rendual capacity for work is needed to be able to advise on and approve a change of

job and rehabilitation.

The working programme of the experimental laboratories required for this purpose ranges from rapid tests for early detection of disease to careful analyses with quality control and a high outlay on equipment. X-Ray diagnosis, electro-cardiograph and spiroergometric examinations, sensory tests using audiometry and optometry and other psycho-physical test series are tasks which can only be performed by highly skilled staff. Then there is the usual aid required in every medical practice for blood sampling, injections, inoculations, etc.

2) With increasing knowledge about the lives than can be saved by effective shock treatment and resuscitation, industrial rescue services are becoming key personnel. Accidents, poisoning and sudden illness (at night, on Sunday and holiday shifts) have to be diagnosed, treated and passed on for further treatment by specially qualified staff working mainly on their own . Rescue equipment has to be operated and rescue vehicles accompaned. An emergency service has to be organized and assistants trained for this purpose. There are notifications and reports to write up and contacts to be established in a very wide range of fields.

   These tasks require considerable knowledge, ability, experience, adaptability and constant readiness to learn.

3) Modern industrial medicine involves measuring, observing and explaining relationships; the same attention must be given to people and work, individuals and society, this being the only way in which to achieve a sophisticated knowledge of the many health hazards at work and in the environment. Only if one's judgement of the work is sound can one make pertinent suggestions for improving it.

   The main tasks of the industrial medical technician are :

cooperation in the organization of work, work study, special tests in the specific field of the physiology of effort and ergonomics at the workplace and during task performance, chemico-physical tests, measurements of climate, air, light, noise, vibrations etc., tests and the analysis of them in the chemico-physical laboratory, documentation on the progress and results of examinations, maintenance of measuring and test apparatus and medical equipment. All these duties presuppose training in technical engineering.

4) The administrative duties and arrangements connected with industrial medicine are numerous and essential to the smooth coordination of the various fields of activity. They range from clerical work of all types, statistics and equipment management to the largely independent organisation of individual and mass examinations, inoculations, etc.

The type and scope of the work in each of the four fields depend on the specific needs of the industry at the time and this also determines expenditure on apparatus and the number of staff required in the industrial medical service. It has proved advisable to start with the basic essentials adding other elements piecemeal according to need so that industrial medical care can be given at each level. There must, of course, be a certain overlap between the individual fields in order to overcome staff difficulties during holiday and sickness leave.

Experience has shown that it is fairly difficult to find suitable technical staff for industrial medical duties.

Of course finding good clerical staff or an experienced doctor's assistant is no real problem as both adapt quickly to their new duties.

What is difficult is the choice of suitable medical technician to meet the needs of industrial medicine. It is a statutory requirement that she should have had specialist training in either laboratory or X-ray work. In an average-sized industrial medical service she is expected to perform both tasks and many others, such as electro- and phonocardiography, spiro-ergometry, audiometry and optometry for which she must qualify by means of in-service training.

There is so far no compulsory job profile for the extremely important work performed by the industrial rescue service. First-aid workers who are engaged are only expected to produce evidence of basic training in first aid or nursing with the possible addition of a short period of practice in an accident hospital. In large concerns state examined male and female nurses undertake rescue work for which they are essentially untrained. There are no special training and further education centres designed to meet the needs of industry and there is no absolute obligation to continue improving knowledge and proficiency. According to the Industrial Safety Law, the industrial medical officer alone is responsible for "giving his assistants first-aid training" which is an unrewarding task if these persons are without the basic qualifications for effective training. The job profile of the rescue worker, which has so far existed only in draft form, is again based so exclusively on resuscitation that the field is too narrow for the requirements of industrial first aid.

There are no specialized staff at all to carry out the duties to what the Industrial Safety Law gives priority - humanizing work and reducing the attendant hazards.
In industry itself there is very little tendency to allow the medical officer a field of activity already occupied by working parties engagned on time- and-notion studies and ergonomics; or if such a concession is made it is not

primarily humanitarian reasons but for the predominantly economic consideration of optimising production.

Because of this and to prevent any further deterioration in the situation, it is suggested that all the duties in the four fields should come under a single profession with a state-recognised job profile known as 'industrial medical auxiliaries'. This formula would meet the more limited needs of small and medium-size industries, particularly those with only part-time medical officers.

As the industries to be served increase in size and increasing demands are made on the industrial medical officer, who is expected to cooperate in all matters related to work organization, the employment of specially qualified technical staff must be looked at from a different angle. Because of the increasing number of statutory duties, industrial medical officers have called for specially qualified industrial medical technicians to assist them in performing these tasks.

To prevent any undesirable trends the following points are to be taken into consideration :

Facilities should be provided for taking courses in such training at various school-leaving levels and from professions providing adequate previous experience.

The technical training should be tailored to the needs of industrial practice. It should be provided in a number of successive stages and each stage should end with a state examination providing a qualification.

The technical knowledge thus acquired must be multi-purpose and provide openings for professional advancement.

Permission to follow a profession should depend on constant proof of further training.

In order to achieve standardized regulations at Federal level, agreement must be reached between the various non-medical auxiliary professions.

In view of the recent decision on the freedom of movement for doctors in all countries of the European Communities, we must aim at standardizing training and the mutual recognition of professional qualifications and diplomas.

The Industrial Mutual Accident Insurance Associations' 'Guidelines with regard to auxiliary staff, premises, equipment, instruments and supplies for industrial medical officers' must take provision for technical staff with the right qualifications to meet the needs of the practice.

There is then the question of the status of the medical auxiliary within the undertaking. Whether the new professions will be given to public recognition due to them will depend very much on grading within the industrial hierarchy.

DISCUSSION

Dr Hentz

I am very grateful to Dr Knieb for his report. I found it extremely interesting, particularly since it deals with something which deeply concerns us. In fact, a study is now being carried out, which in a few months time should result in proposals for training of paramedical staff within the Community based on the schemes now operating in the various member countries. We will no doubt have some suggestions to make on this to the authorities concerned, so that harmonised training of paramedical staff may be controlled by regulations or legal measures in the different countries.

I would like to ask Professor Knieb a short question. Under point 3 in his report, I believe he mentioned ergonomic studies and work organisation among the duties of the industrial medical officer. Is such a definition of the various duties of the medical officer readily accepted in the German Federal Republic, or does this present problems, as seems to me to be the case in other countries?

Dr Knieb

In going beyond the basic activities covered by industrial medicine, that is, its practical problems and those encountered in the industrial clinic,not enough importance has been attached to the problems involved in adjustment to work and work organisation. This inadequacy has subsequently been tackled by engineers. They, however, based themselves on optimising production. Of course, they have made great efforts to fill the gaps, but the developments have been unsatisfactory, as the humanitarian aspects of the concept of work have been neglected. Emphasis mut not merely be placed on output, but also on maintaining the good health of the workers for as long as possible. Such aspects have not been considered essential. Furthermore, although study groups have been set up to examine the problem from a technical and economic point of view, as part of time-and-motion studies and ergonomics, here again the medical officer is not directly consulted and plays a secondary role. This situation is most unsatisfactory from the point of view of legislation : for, if the medical officer is to deal with the question of the concept and organisation of work, he must be allowed to take part in defining a team's objectives and in putting forward priorities which take account of human problems as well as material ones. Ergonomics, therefore, cannot be studied in a vacuum. All the sectors concerned must be included, and the medical officer must have his say in drawing up and defining tasks.

Professor Symanski

Dr Knieb has given as an exhaustive report on the situation in the Federal Republic. I should like to add a few comments in connection with the training of medical assistants and techniciens in other countries. I should in particular like to turn to the case of the United Kingdom, and to English-speaking countries in general, where the profession of "industrial hygienist" has become a reality. Perhaps our British colleagues present could briefly describe this occupation. I believe that the medical officer can be relieved of a considerable amount of work and that good teamwork can be accomplished between medical officers and industrial hygienists. Perhaps Dr Duncan could tell us something about this.

Dr Rothan

If a French doctor in charge of industrial medicine, and not one of our British colleagues may be allowed to speak .. First of all I would like to compliment Dr Knieb on his excellent report. The situation he described exactly corresponds with that pertaining to France. In France, of course, industrial medicine was introduced in 1946, and as you know we have made considerable developments in this field, but we are also experiencing the inadequacy of which Dr Knieb was complaining, as regards to involvement of the industrial medical officer in studying workplaces and working conditions. In order to improve this situation, we too have sought to provide help for the industrial medical officer in evaluating working condition, quite apart from the normal assistance given to him by his auxiliary staff. First of all, we thought of making better use of industrial nurses. We actually have nearly two thousand industrial nurses in our country. However, as in Germany, their training is not geared towards the duties they are called upon to perform in a working environment. Therefore, the problem of supplementary training exists. The Ministry has also just issued a document which determine the duties of these industrial nurses as regards assisting the medical officer and studying and evaluating work environments.

Another question raised by Dr Knieb which of course will require further work and consideration concerns the equivalent structure or equivalent staff which would be used in common medical services for several firms, covering small and medium-size industries - in France this involves 80% of the workers to whom industrial medicine is available. In my opinion this point must be given future consideration and study at Community level.

Professor Bollinelli

As from this year, the Institute of Industrial Medicine in Toulouse is running a university diploma intended to provide training for auxiliary staff in industrial medicine and in environmental metrology. The job profile corresponding to this diploma is completely in line with that which

Dr Knieb described to us. Naturally, our intention in this is not to train ergonomics engineers. This diploma is on an equal level with the qualification for medical auxiliaries, and I think that there should be several ways of gaining admission to this training course. As a particular example, as far as France is concerned, it is possible that some people may be able to obtain this diploma as part of in-service training. It would perhaps be best if these experiments take place progressively, since the requirements of industry as regards qualified staff cannot be accurately assessed, especially in small or medium-size firms.

Mrs Dr Stollenz

Mr Chairman, I thank you for giving me the last word and I shall be brief. I too would like to offer my thanks to you, Dr Knieb, for your most relevant report. As you know, I share your views. However, I would like to stress that although cooperation between ergonomists and industrial medical officers is possible in large companies, the situation is slightly different in small and medium-size firms. Responsibility is perhaps the objective we could set ourselves. In this way I believe we could find the right level for cooperation between medical officers and non-medical assistants respective to these different situations.

I will now finish with a criticism. You dealt with the problem of specialized staff in the field of industrial medicine, and in so doing, you put the cart before the horse. I hope that in the context of liberalisation, it will be possible to give priority to the harmonisation of the theoretical and practical training of industrial medical officers themselves. In my opinion, this is one of the Commission's main tasks. Its function should be to define a broad strategy, and it should not fail to take industrial medicine into account when it goes on to define the guidelines for other fields. Thank you.

THE PRE-EMPLOYMENT MEDICAL EXAMINATION FOR ASSESSING FITNESS FOR WORK IN ECSC INDUSTRIES

Dr. C. AMOUDRU, Paris

Why include the question of pre-employment medical examinations (PEME) in our work programme when it is probably one of the oldest forms of preventive medicine and has not been the subject of any publications or significant discussions at our meetings for quite some time?

In fact it is only natural that the European authorities should be concerned with the matter as the Rome Treaty provides for the freedom of movement for workers. As Dofny has pointed out, for this to be effective, "employees wishing to make use of this provision should have the assurance that for a given job, the decisions taken at the pre-employment medical examination in the host country has every chance of being identical to that taken in their country of origin". At the very least, in my opinion existing practices should not be contradictory and should not constitute unnecessary obstacles to the exchange of workers or, conversely, should not cause the migratory movement to be diverted towards countries where industry is more liberal with regard to medical requirements. It therefore became necessary to compare the situation existing in the various Member States and establish points of agreement or disagreement.

At a more general level, it should also be noted that selection procedures, which once seemed a matter of course, are now questioned in some circles. The critics maintain that work is a basic right and that the applicant's selection or rejection represents denial of justice. Another less radical view is that the failure rate - i.e. the ratio of unfitness reports to the number of applicants examined - is too high to be acceptable from the social point of view. There was therefore good reason, to take stock of the experience and opinious of works doctors in the Community's coal and steel industries and examine whether in fact the PEME was an obstacle to workers seeking employment and a relic of the discretionary powers of the employer or if, on the contrary it was an act of social medicine in the full sense of the term.

It was for these reasons that the Working Party of the Coal and Steel Industrial Medicine Committee decided to conduct an extensive survey of medical departments in these two branches of industry. A questionnaire consisting of about loo questions was therefore drawn up and tested by conducting a pilot survey of about a dozen doctors. Amendments were made on the basis of the opinions received and, in 1974,the new version was distributed in the various Community Countries. It contained several sections :

a) type of enterprise and the function of the works doctor,
b) administrative and legal character of the PEME
c) purpose of the PEME (selection or orientation ?)
d) technical aspects and equipment
e) fitness standards used and their validity
f) medical service liaison for the PEME
g) effective failure rate in 1973.

Thus there were about loo questions in all. Though most of them were of the "closed" type (yes or no answer) to assist processing, there was ample opportunity for doctors to comment and give personal opinions. If they so wished, respondents could make their replies completely anonymous.

Of the 89 replies received, it was possible to process 86 effectively. Their origin was as follows (by country) :

- United Kingdom : 32
- France : 22
- Federal Republic of Germany : 15
- Italy : 1o
- Luxembourg : 4
- Belgium : 2
- Netherlands : 1

(by branch of industry)

- Coal : 41
- Iron or mines : 4
- Steel : 41 (1)

Unfortunately, owing to the large quantity of material received, it was not possible to have all the replies translated in full and as my knowledge of languages is rather limited, I was not able to understand all the comments perfectly, particularly those in German. There will therefore be some gaps in my report and I hope allowances will be made if I have misunderstood any of the concerns or suggestions expressed. Nevertheless, all the closed questions have been properly processed.

The survey related to 1973. At that time, there were more than 7oo ooo workers in the industries questioned and our study is therefore highly representative. I shall attempt to pick out the points which I feel are most significant.

A. LEGAL AND ADMINISTRATIVE ASPECTS

In 1973 PEMEs were required by law in four countries. In the others they were only obligatory for certain types of employment or certain categories of staff (e.g. adolescents under

(1) Some replies contained information on the PEME for one or more iron ore mines belonging to the steel works in question.

18 years of age). However, in practice they were used systematically in all the enterprises in question.

In 75% of cases the PEME was always conducted <u>before</u> employment was actually taken up; in 20% of cases, it was conducted either before or after work was started and in 5% of cases it was conducted after the subject had started work. In their comments, many doctors expressed the wish that the PEME should be conducted before employment, emphasizing that at the very least it was paradoxical to have to tell a worker that he was not fit for a job he already had. On the other hand, the works doctor could, after conducting the PEME, state that the candidate was <u>provisionally fit</u> subject to a medical check-up a few weeks or months later. We shall refer to this as conditional fitness. It was authorized in 73% of cases and appears to be a little more frequent in mining than in the steel industry. In nearly all cases, the fitness report was submitted directly to the employer. Only in 36% of cases was it also communicated to the candidate. I felt it would be interesting to find out if there was any possibility of appeal - in theory or in practice - against the findings of the PEME, either on the part of the enterprise or on that of the applicant. In 32% of cases, it was stated that the employer could require the applicant to be re-examined and in 42 % of cases, the applicant could also insist on a second examination. However, in practice very little use was made of this provision.

B. <u>PURPOSES</u>

The second group of questions related to the <u>practical aims</u> of the PEME. There were four possible replies :

1. Detection of unrecognized diseases liable to represent a risk for other workers.

2. Determination of general fitness for work underground or in steel works.

3. Examination for a specific job.

4. Biological orientation of the work force.

The first question was thus mainly related to preventive medicine; the second and third were typical of the selection function while the fourth dealt with the tendency not to fail applicants but to appoint them on the basis of their individual abilities. Respondents were asked to classify these objectives by order of priority. In 66 % of cases general fitness (question no. 2) was given top priority and more than one doctor felt it necessary to point out that versatility was a basic requirement for many new employees. Detection of diseases (question no. 1) came in second place with 53 % of the results; then came fitness for a specific job with 46 % and biological orientation with 42 %. Some doctors pointed out that though biological orientation came foremost in their own wishes and ideas, it dit not correspond to a real requirement within industry, at least at the time of employment. Thus the selection function seems to be the most important. However, we shall see later the slight effect it usually has on the applicant.

C. TECHNICAL ASPECTS

After explaining the legal character and the aim of the PEME in industry, we may now consider the practical aspects of the examination.

We shall pass over technical aspects such as the types of illness contra-indicating a given type of work, the most important organs or functions to be examined for specific occupations or jobs and the tests to be conducted, as these cover too wide a field to be considered here.

Generally speaking, there was in fact excellent agreement between the replies given in this connection, though of course there were the inevitable differences on eyesight requirements.

The medical examination was always preceded by investigating the applicant's medical history. In nearly all cases, this was done by oral questioning. In one third of the replies, a written questionnaire was also completed. Works doctors were also asked whether they could obtain details of the applicant's medical history either from his GP or from the works doctor at his previous place of employment. A positive answer was given in 8o % of cases but many doctors stressed the care which had to be used in this connection to avoid obvious deontological problems. The information was usually obtained from the applicant himself and the principle of professional secrecy was thus fully respected.

In addition to the clinical examination, various supplementary examinations were usually carried out. The works doctor seemed to be allowed great latitude here, as also evidenced by the substantial amount of equipment available to him. In four cases, however, it was impossible for the doctor to require additional examinations apart from the tests normally conducted in the medical department such as radioscopy or urine analysis.

D. FITNESS STANDARDS

After conducting the medical examination, the doctor has to decide on the applicant's fitness. The fourth group of questions was therefore aimed at investigating whether such decisions were based on the doctor's personal experience alone or on pre-determined fitness standards.

All countries doubtless had legal fitness standards for certain occupations such as benzol workers. However, what was the position for jobs other than those for which there were specific requirements for toxic conditions? Almost all the replies mentioned safety standards for work underground. On the other hand, in the steel industry only 65 % of the replies referred to general standards of fitness. This difference is not surprising as very strict regulations on mining have always been applied throughout the world. It was also found that there were often fitness standards for safety occupations and here the percentage of positive replies was the same for the steel industry as for mining. We shall be considering the doctor's opinions on the validity of these standards later.

We also felt it would be interesting to investigate the significance of psycho-technical examinations in the PEME. In fact, these were only carried out in half the cases. Doctors were also asked if subjects were declared fit or unfit by the medical and psycho-technical departments separately or whether a joint decision was taken. The replies were equally divided between these two procedures.

E. SOCIAL LIAISON

Finally, there was the important problem of the works doctor's social liaison at the time of the PEME. We have seen what possibilities doctors had of communicating with the subject's GP or with the works doctor at his previous place of employment. Another important social factor was of course that of reorienting subjects found to be unfit at the PEME. In 7o % of cases, it was possible to refer unsuccessful applicants either to the works social department or, more often, to a public body, such as the Agence Nationale de l'Emploi in France. It seams to me that one of the most important things to investigate was wether the works doctor was informed by the works of the entrant's success in his job. This in fact would be the only means for the doctor to assess objectively his own fitness criteria or the standards for entry. In 3o % of cases, the doctor obtained no information in this connection. In most of the other replies, information was said to be occasional and unsystematic. It is therefore not surprising that the answers to the questions on the validity of the standards lack conviction. Most doctors say they appear satisfactory, that they have proved to be useful from the point of view of fitness within the enterprise but that they certainly are not successful as fitness indicators. Others prefer to restrict themselves to their clinical significance and their own personal knowledge of job requirements. The validity of the standards has obviously not generally been the subject of systematic enquiries and this is most regrettable.

F. FAILURE RATE

The failure rate is the percentage of subjects the doctor declares to be unfit out of the total number of subjects examined. In mining, the average failure rate was 5.7 %, if it is supposed that the number of examinations carried out by each respondent was more or less the same, though this was certainly not shown to be the case. However, there was only a slight deviation from the mean, the range varying from o.2 % to 16 %. In the steel industry, the failure rate calculated in the same way was 5.5 %. However, in this sector, the Italian replies contained two exceptional rates, 5o % and 65 %. This was possibly a result of the employment situation in some areas of Italy rather than an indication of poor fitness or very high industrial requirements. Thus the average failure rate for these two industries was only just over 5 %. This completely disproves the critics' allegations I referred to at the beginning of the report and clearly shows that in this respect industrial medicine is faithful to its social vocation; at least as far as coal and steel are concerned, it is clear that the PEME is based on very moderate requirements, and, in Dofny's words, does not seek to do more than "avoid gross errors of employment".

However, if we consider that in a number of replies, the failure rate was below 1 %, we may well ask whether the purpose of the PEME, at least in the companies concerned, has not been substantially modified without our being aware of the fact. Indeed, though the stated aim was primarily selection, such a low rate shows that the applicant's fitness was usually good, either owing to an increase in the general standard of fitness, or because applicants were fully aware of the job requirements and did not apply unless they were fit. This would mean spontaneous self-orientation of the work force. However, if this is the case, is there any sense in conducting examinations which in 99 % of cases state applicants are fit ? Could they not simply be dispensed with? It seems to me that in such cases the PEME serves two main functions :

a) First and foremost it provides a report on the worker's state of health when he takes up employment and this may be used as a basis for comparing the results obtained in all the periodic examinations carried out subsequently.

b) However, at the same time it provides the worker with an initial introduction to the undustrial medicine department of his new company. His impression of this first experience, whether justified or not, is likely to have a long-lasting effect on his relationship with the works doctor. It may well be asked if one of the functions of the PEME is not therefore to give the worker a brief explanation of how the department is run, to introduce him to the doctor and the medical staff whom he will have to contact later in connection with the health regulations, and to explain to him briefly what advantages workers have to gain from the preventive medicine and industrial hygiene services of the enterprise. The introduction would therefore work both ways : the doctor would get to know the worker and the worker would obtain information about the works medical service. It seems to me that this would provide a means for improving the workers' understanding and use of industrial medicine.

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The purpose of the PEME obviously goes far beyond this psycho-social aspect. Nearly everywhere it is required by and practiced in accordance with the regulations in order to determine :

- whether the applicant is suffering from an illness representing a risk to other ;
- whether he is medically fit for the work in question;
- which jobs he should not be given for medical reasons and which he is best suited for. We have seen however that moderation and good will are practised in the use of the powers granted and that - at least if the medical opinions expressed in 1973 are maintained - the PEME does not present an obstacle to the freedom of movement of workers within our Member States.

DISCUSSION

Dr Foehr

I would like to thank Dr Amoudru for his excellent paper.

Dr Noesen

Mr Chairman, ladies and gentlemen, I would also like to thank Dr Amoudru for his paper.

I shall not discuss its content. I would merely like to comment on two sentences which could possibly mislead some members of the audience. Dr Amoudru's paper is certainly entirely valid for those countries where the pre-employment medical examination is compulsory and is common practice. Two sentences in his second paragraph, however, call for comment. There we read, on the one hand, that 'the Treaty of Rome provides for the freedom of movement of workers', and, on the other, that 'the pre-employment medical examination does not constitute an obstacle to the movement of workers within our Member States'. There is no longer any mention of freedom of movement in this second sentence.

In order to avoid confusion, I should like to point out that not all the discussions which took place in Brussels on the freedom of movement for workers and health examinations dealt with the pre-employment medical examination. This last was omitted intentionally. The only thing agreed upon was that each country reserved the right to carry out, in the interests of public health, a check on the state of health of the immigrants from another Member State of the European Community. There was therefore no question of fitness for work. This difference does not mean that the criteria for the pre-employment medical examination might not have a favourable or unfavourable influence on certain migrants who could feel encouraged or discouraged by the difficulties of passing this examination. In the case of countries where pre-employment medical examination is not compulsory or common practice, a distinction must obviously be drawn between the examination for entry into the country, which is a state check carried out in the interests of public health, and the pre-employment medical examination within the enterprise, which is something else.

Dr Claass

I note that on page 7 of his excellent paper, Dr Amoudru uses the expression 'failure rate'. The concept of 'failure' in present-day language to my mind corresponds to the choice of the subject possessing the highest degree of fitness. Furthermore, it is an expression which does not always find favour with workers. This being the case, I wonder whether it might not have been preferable to speak of 'unfitness rate'.

Dr Rothan

Mr Chairman, I would like to add my congratulations to Dr Amoudru for his excellent report. I would like to make three brief remarks on this subject.

The first is that we have also been able to check the 1% unfitness rate, albeit in industrial medical services different from those which have been studied here. If inter-enterprise services are considered, the rejection or unfitness rate almost doubles. In my opinion, this shows that in the case of such services industrial medical officers are not so well acquainted with working environments. We should take full account of this fact in our training schemes.

The second remark concerns the concept of versatility which Dr Amoudru quoted, but did not adopt as part of his own viewpoint. I feel it necessary to underline the danger of this concept, and the care which industrial medical officers must take when asked to define fitness for a long list of jobs. It is acceptable for the industrial medical officer to be asked questions, but it is not acceptable for him to be asked to draw up a catalogue of fitness criteria. The result of this as far as the personnel services are concerned is generally a ruthless weeding-out process, for which the industrial medical officer is afterwards held responsible. In France, attention has been drawn to this practice which was especially common in certain national enterprises, but sometimes also in foreign enterprises establishing themselves in France.

The third, very quick, remark is that in the case of migrant workers or, more generally, workers assigned to jobs which are dangerous or involve toxic conditions, the pre-employment medical examination can provide the starting point for a programme of information and training in which the industrial medical officer must play his part, if necessary with the assistance of auxiliary personnel of the kind mentioned earlier.

Dr Amoudru

I should like to thank those who spoke and tell them that I can only agree with all the useful points they raised concerning a paper which was too short and incomplete; I hope that these points may be included in the minutes of the discussion, because they give this brief survey an additional dimension. Thank you.

ERGONOMICS AND INDUSTRIEL MEDICINE

Prof. J. DE GROOT, Ijmuiden

Introduction

In his book 'ERGONOMICS' Murrell said this about the origin of the word ergonomics :

" A decision was reached to form a Society which should being together anatomists, physiologists, industrial medical officers, industrial hygienists, design engineers, work study engineers, architects, illuminating engineers, in fact anyone, whatever his background, whose work was related to any aspect of human performance. An immediate need was to find a name for this interdisciplinary field and it was finally decided to coin a new word, ERGONOMICS, from the Greek ergos : work; nomos : natural laws ".

The word ergonomics, which was originally chosen to denote the field of activity of a society, quickly became wider known, to the extent that it is now part of everyday speech.

As it became better known it also took on a broader significance than the designation of the area of interest of a society. Just how wide a meaning now attaches to it can be judged from the many statements which have been made about ergonomics over the years. A selection of these will be found in the appendix. One should not be too surprised at the differences between the various statements. The concept of ergonomics is used by doctors, engineers, psychologists, etc., to designate scientific and practical activities and plays a part in the culture of various nations. Everyone tends to use it from his own point of view. But one should not pay too much attention to differences in formulation. This is all the more true in that thanks to these differences a common view has become clearly apparent. In this connection we might make the following remarks.

The subject of ergonomics is human work, or to put it more correctly, perhaps, man at work.

The characteristic feature of modern work is that it is done on and with tools and machines, in an environment dominated by technology and organization. This places man before a series of problems. The task of ergonomics is to examine these scientifically and to contribute to their solution by applying its principles to practice.

The method of ergonomics is the interdisciplinary approach. This has been said so often that it has almost become a commonplace. So let us put it somewhat differently : ergonomics uses all the scientific knowledge and all the scientific methods which are relevant to the achievement of its objective and applies these practically with the closest possible cooperation of all persons who are able to make a contribution.

The objective of ergonomics is to achieve optimum mutual adjustement of man and his work (ILO). Answers must therefore be found to questions such as : 'what type, degree of difficulty, duration and rhythm of work, what kind of tools, machines, instruments of measurement and control and what working environment are best suited to the characteristics qualities (capacities) and requirements (motives) of man. Perhaps the pithy pronouncement of Scherrer : 'On entend par là l'adaptation du travail à l'Homme' best reflects the meaning and significance of ergonomics.

Ergonomics plays an important role in industrial medicine. We shall now consider previous developments in this field.

Work and sickness

Hippocrates, 'the father of medicine', wrote : there are many trades and occupations which cause discomfort and suffering to those who practice them. After him doctors continued to turn their attention to problems of work and health. One might mention names such as Paracelsus (1494 - 1541), Ramazzini (1633 - 1714), Thackrah (1795 - 1833), Coronel (1824 - 1892), etc.

They compiled an extensive stock of information about diseases and other abnormalities occurring in various occupations. Their interest was of a mainly medical and clinical nature; prevention was still largely unknown. That is quite understandable. At a time when starvation, diseases such as the plague, smallpox and cholera, whether accompanying war or not, literally decimated town and country populations, the health hazards of work could hardly be regarded as anything but a marginal problem. This state of affairs changed when increasing welfare began to show its effects and the effects of work on the health and general well-being of workers became increasingly more apparent. This led, during the last century, to the first laws for the protection of workers. In some cases the medical profession played an important role in bringing about the promulgation of these laws. Doctors also soon became involved in their implementation. These men can be regarded as the first industrial physicians.

Some years later, in the first half of this century, doctors began to make their appearance in industry and the industrial medical services were created. It was during this period that the preventive approach developed.

The pre-employment examination and the many types of periodical medical examination are perhaps the best known examples of the systematic, preventive approach. Thanks to these medical prevention measures it is possible to prevent damage to health and the aggravation of initial symptoms. In principle, this is done by isolating the persons concerned from the influence of the harmful factors. The actual hazards in the work, the technical processes or the working environment are not affected,however, by this action. Technical prevention measures are therefore necessary in addition to medical prevention. In technical prevention we can distinguish two main areas, safety and industrial hygiene.

The aim of the safety measures, setting aside the influence of behaviour, is to prevent the occurence of accidents and occupational diseases, mainly by technical means.

Industrial hygiene developed somewhat later and to varying degrees in different places. Using chemical, physical and technical studies and measures, industrial hygiene concentrates on factors in the working environment. It involves action against noise, extreme temperatures, poisonous and other harmful substances, harmful radiation, etc.

There are close links between medical and technical prevention. Toxicologists, epidemiologists, industrial medical officers and others are undertaking research to determine the concentrations or other values above which the effects on health of potentially harmful factors can become noticeable. These constitute the basic data for technical prevention.

Thanks to the periodical medical examination, industrial medical officers are able to assess the effects of the technical prevention measures adopted, for example by audiometric examinations and by physical and chemical analysis of metabolic substances in the blood and urine.

In matters of safety, and in particular industrial hygiene, there is close cooperation between engineers, chemists, physicists and industrial medical officers, the aim of which is to prevent accidents and occupational diseases or other disorders from occuring as a result of work and the effects of the working environment.

Work and health

To paraphrase a definition by the World Health Organization

(1947), good health does not consist merely in the absence of sickness and disability, but corresponds to a state of complete physical, mental and social well-being.

Whatever one may think of this and the myriad other definitions of a similar type, they all reflect the now generally accepted view that the absence of sickness or disability does not necessarily imply good health.

Good health, therefore, also deserves to be described in positive terms of general well-being. This point of view had a considerable influence on the development which health care underwent in the last few decades and is still undergoing now. This applies not only to general health care but in particular to industrial medicine.. Alongside the concern with sickness and accidents and the possibilities of their prevention, efforts have therefore begun to be made in industrial medicine to use industrial medical knowledge to improve the general health, or rather the general weel-being, of workers.

Perhaps I am over-generalizing somewhat, but I would say that industrial medicine has now added this positive approach to health protection to its clinical and subsequent preventive approach. Or to put things more cautiously, it is now engaged in doing so. This had led to a desire for cooperation between psychologists, social psychologists, social workers, personnel officers and other persons specialized in the field of the protection of the personal well-being of workers and who have specific tasks in industrial undertakings.

In matters of prevention it quickly became clear that it was not enough to direct this at the workers (medical prevention) but at the work itself and the working environment (i.e. technical prevention). The industrial medical officer has a role to fulfil in both these areas.

This also applies to modern health care. It is not sufficient to direct this at the workers alone; work and the working environment also merit attention because it is precisely these factors which can impair the physical, mental and social well-being of workers. As this well-being is to a great extent a medically qualified concept, the industrial medical officer has a considerable task here since he must assimilate a whole new approach. Modern industrial medicine no longer involves merely determining the limits of occupational and environmental burdens beyond which health hazards exist, but also and more particularly the limits within man works best, and the types of work and working conditions most conducive to the well-being of workers.

In industry, the type of work and the conditions in which it is carried out are strongly influenced by technology and organization, which more than anything else determine the actual nature of the work. The industrial medical officer should therefore pay full attention to these factors, and the questions he will ask himself are, for example: what requirements must work and the working environment fulfil in order to avoid great and unnecessary fatigue; what is the best working position; under what circumstances can the worker carry out his visual tasks best and what climatic conditions are within the limits of comfort?

These and other questions faced by the industrial medical officer are basically concerned with physical well-being. But there are similar questions of a psychological and sociological nature. The cooperation of the industrial medical officer with those responsible for these questions is therefore also necessary. It was said a few moments ago that technology and organization determine the nature of industrial work. Specialists in these fields, i.e. engineers, chemists, physicists and work study engineers should therefore also be involved in this cooperation, since it is on them that the realization of medical and psychological aims regarding work and the working environment entirely depends.

In order to achieve healthy conditions of work, the work and the working environment must be adapted to man's physical and mental characteristics and his psychological and social requirements. This is only possible through the multilateral cooperation of all those persons I mentioned a few moments ago.

If we compare this with what was said about ergonomics in the introduction, it will become clear that ergonomics is an important, not to say indispensable, aid to the industrial medical officer in his endeavour to ensure proper health care.

Ergonomics might be called the industrial medical officer's godsend, were it not for the element of chance which is present in this expression and which is alien to ergonomics. Industrial medical officers have played an important part in its development, as they do now in its application. Ergonomics owes part of its origin to industrial medicine.

Moreover, the aspiration for well-being at work is not the specific prerogative of industrial medical officers. Many other people are concerned with it too.

Well-being is in any case not exlusively a matter for specialists. Specialists, even working in interdisciplinary cooperation, cannot exactly define what well-being is. True, they can indicate a number of basic conditions for well-being. But in the last analysis it is for the workers themselves to indicate what circumstances are conducive to well-being and when. It is clear, therefore, that in matters of ergonomic and industrial health care the voice of the workers and their representatives must be heard. They too must be drawn into this multilateral cooperation.

Ergonomics in the enterprise

For the sake of clarity, it is perhaps useful to make a distinction between ergonomics as a science and ergonomics as a practical field of application.

The former, i.e. scientific ergonomics, is practised in scientific institutions and in a few very large undertakings.

There is no need for us to go closely into ergonomics as a science. Suffice it to say that scientific research using special analytical procedures tends to concentrate on problems of detail rather than on the search for the overall solutions which are required in practice. In scientific ergonomics, the individual sciences involved therefore often play a major role. At any rate, this is so in industrial medicine and experimental psychology.

In industry we encounter applied ergonomics, but not only there. Ergonomics can (and must) be applied wherever human work is carried out, in agriculture, business and even in the home, though these areas cannot be considered here. Applied ergonomics can be devided into two parts, design ergonomics and corrective ergonomics.

Design ergonomics is applied to the designing of technical processes, machines, tools and installations. This type of ergonomics is already applied in the selection of processes. A process which does not give rise to the emission of harmful gases, poisonous substances or dangerous radiation is from the ergonomic point of view preferable to others that may do so.

Safeguards are admittedly often possible to protect men from harm,but they can fail. Other questions arise regarding the distribution of functions between men and machines. It is a mistake to design a machine in such a way that its operator is obliged to perform an endlessly repetitive routine action, for which he is not built and even less motivated.

Much more could be said about this. When a factory is being designed a whole series of decisions has to be taken which are of decisive importance for the well-being of those who will work in it.

Designing itself is the engineer's job. The engineer must be fully aware of the consequences of his technical choices on the health and well-being of the workers. Ergonomics should therefore undoubtedly be included in his training programme. He cannot know everything, of course; he is first and foremost an engineer. He must therefore be assisted in his designing work by a team of specialists drawn from many different fields. This team must always include a specialist in industrial medicine, on account both of his specific knowledge and of his responsibility to protect and promote health. His job is of such importance that he should be reserved the right of veto in the team. Questions regarding which he has serious objections can then only be settled at the highest level.

The setting-up of a team of this type implies the possible need for prolonging the design phase, with all the attendant implications. Experience shows that the danger of delays can be reduced to a minimum, though not alltogether avoided, by efficient organization.

Corrective ergonomics is concerned with already existing conditions, the dangers and disadvantages of which are well-known to the industrial medical officer, as a result both of his own experience and of complaints which people make to him about them and in certain cases as a result of sicknesses (or accidents) caused by them. And this is not the only reason why he must play the major role in corrective ergonomics; there is also the fact that providing personal health and healthy work conditions is his exclusive responsibility and he therefore occupies a statutory or guaranteed independent position.

Corrective ergonomics is also a matter requiring inter-disciplinary cooperation, and here, too, the workers themselves and their representatives must be actively involved. The manner in which this is done depends, for each of the participants, on the nature of the subject, the structure of the undertaking and other considerations.

Small undertakings can avail themselves of fewer specialists than large ones. This does not necessarily imply any drawbacks for the application of ergonomics. Someone once called ergonomics the science of common sense. We may assume that workers, technicians, works doctors and others in a small undertaking do not possess less of this than those working in a large one. Ergonomics does not have to be practised only at the highest possible level.

Moreover, the institutes engaged on ergonomics research are of great importance for the smaller undertakings. These institutes can be expected to go beyond the stage of scientific ergonomics and be fully aware of the need to perform practical services.

Ergonomics and the works doctor

For the works doctor, ergonomics is one of the instruments which he uses to fulfil his task of protecting and promoting health in the factory.

Not so long ago, ergonomic work was an occupational hobby of a number of works doctors. Those days are now over, in that this hobby - however much it may have been respected - now deserves to be regarded as an obligation. Without the knowledge and experience afforded by interdisciplinary cooperation it is not possible to practise modern, welfare-orientated health care in industry.

On the other hand, without the contribution of industrial medicine, ergonomics would be severely crippled, if indeed it could exist at all.

Sometimes one hears the fear expressed by industrial physicians, and indeed by industrial hygienists too, that they might be outstripped by ergonomics, or rather ergonomists. I would remark in passing that an ergonomist is in fact an impossible hybrid. One can at most talk of an ergonomics engineer, doctor, psychologist, etc. But coming back to this fear, I would say that as such it is totally unjustified. Ergonomics is by very nature a field requiring cooperation and welcomes anyone who is able and willing to make a relevant contribution to it. I would stress that the importance of this contribution is determined by the extent of one's specialized knowledge in one's own field. Cooperation with others requires wider and more profound knowledge of one's own subject than when one can confine oneself to the latter. The proverb "in the land of the blind the one-eyed man is king", does not work in ergonomics.

Conclusion

Three approaches can be distinguished in industrial medicine: the clinical and therapeutic approach, the preventive approach and the positive approach, which might also be called the ergonomic approach. Each of these approaches overlaps the preceding one.

In the ergonomic approach, the dominant aim is welfare at work. If this aim were achieved the preceding approaches could be forgotten. There would then be nothing left to prevent and no occupational diseases or other harmful effects of work to investigate and deal with. We have not yet got this far and probably never will.

Ideals indicate a direction rather than an achievable goal.

However that may be, at a time when work is the subject of many problems, when labour morale is changing and people are apparently showing less interest in earning a living from productive work, the application of ergonomics, i.e. the adjustement of work and working conditions to human possibilities and needs, is a fundamental requirement and one to which high priority must be given.

APPENDIX

OPINIONS ON ERGONOMICS

Burger : "The application of biological knowledge in the field of anatomy, physiology, experimental psychology and occupational medicine to the study of work .....with the purpose of achieving an optimum man-machine system .... in the interest of his own health (and dignity) and in the interest of productivity"
Proc. XIII Int.Congr.on Occup.Health, New York, 864

Chapanis : "Ergonomics is a multi-disciplinary field. It crosses the boundaries between many scientific and professional disciplines and draws upon the data, findings and principles of all of them"

Ergonomics, 13 (197o), 3, 34o

Grandjean : "L'ergonomie était à l'origine une science biologique appliquée aux problèmes de l'homme au travail. Aujourd'hui, les principes de l'ergonomie et leur applications se trouvent dans les domaines les plus variés"

Ergonomics, 13 (197o), 3, 385

Murrell : "Ergonomics has been defined as the scientific study of the relationship between man and his working environment"

Ergonomics, Chapman and Hall, London 1965, p XIII

<u>Scherrer</u> : "On entend par là 'l'adaptation du travail à l'Homme', adapatation qui suppose la connaissance de celui-ci"

Physiologie du Travail (Ergonomie)
I Masson, Paris 1967

<u>Schmidtke</u> : "Die Ergonomie ist eine vergleichsweise junge Wissenschaftsdisziplin, deren Forschungsgegenstand auf die Interaktionen zwischen Mensch und technischen Systemen gerichtet ist. Demzufolge baut sie einerseits auf die Humanwissenschaften, andererseits auf die Physik und die Ingenieurwissenschaften auf"

Ergonomie I, Hauser Verlag, München 1973

<u>Singleton</u> : "Ergonomics is primarily concerned with men, functioning in a technical environment. That is, interacting with complex machines, coping with unnatural environment and participating in the activities of large-scale systems"

Ergonomics, 13 (197o) 3, 347

<u>Wisner</u> : ".... the notion of a man-machine system has appeared to fill a gap between technical knowledge and biology to such a point that this notion has appeared to be the fundamental principle of newly founded ergonomics"

Ergonomics 15 (1972), 6, 6o7

Internat. Labour Organization :

"The application of the human biological sciences in conjunction with the engineering sciences to achieve the optimum mutual adjustement of man and his work, the benefits being measured in terms of human efficiency and well being"

Intern.Labour Review 83 (1961), 1, 1-35

REFA :

"Ergonomie ist die Lehre von der menschlichen Arbeit. Sie beruht auf der Erforschung der Eigenart und Fähigkeiten des menschlichen Organismus und schafft dadurch die Voraussetzungen für eine Anpassung der Arbeit an den Menschen wie umgekehrt des Menschen an die Arbeit. Diese Anpassung liegt sowohl im Bereich der körpergerechten Gestaltung der Arbeitsplätze, der Beschränkung der Beanspruchung durch die Arbeit auf ein zulässiges Mass und der Gestaltung der Umwelteinflüsse als auch im Bestreben nach einem wirtschaftlichen Einsatz menschlicher Fähigkeiten"

Société d'Ergonomie de langue Française :

"L'Ergonomie regroupe les connaissances de physiologie, de psychologie et des sciences voisines appliquées au travail humain, dans la perspective d'une meilleure adaptation à l'Homme des méthodes des moyens et des milieux de travail"

Nederl.Vereiniging voor Ergonomie :

"Het zodanig ontwerpen van produkten, gereedschappen, werkomgeving en werkmethoden, dat een optimale efficiency, veiligheid en comfort wordt bereikt bij bediening en onderhoud van het mens-machine systeem"

DISCUSSION

Professor Odescalchi

In his comments Prof. Odescalchi made some additional observations on the attitude of enterprises and workers to ergonomics. If, as Prof. De Groot had stated, ergonomics had always been the science of common sense, industry would not be typified by the constant risk of injury to workers as it was today.

This was why more and more was being done on promoting ergonomic developments.

However, the objective of ergonomics must not be increased productivity but the improvement of the well-being of man at his workplace. Since shop practice as a rule was orientated exclusively along the lines of rationalisation, difficulties in shop practice frequently arose because of the above-mentioned objective of ergonomics. It was therefore necessary for the fact of the need to humanize work to be integrated systematically into the overall industrial concepts of enterprises.

The realisation of the aims of ergonomics required an interdisciplinary team. In this context, Prof. Odescalchi referred to an interesting description given by Mrs Jacobi at a conference in Luxembourg of the nature of the contributions of the individual disciplines to an ergonomics team. In such teams the task of the industrial medical officer was to act as a channel for ergonomics activity within an enterprise. He should determine the injuries and stress conditions to which workers were exposed and request the technicians to attempt to find a remedy.

On the basis of personal experiences, Prof. Odescalchi stated that a great range of information that was extremely useful in tackling ergonomics problems could be obtained from the labour force, if the objectives of ergonomics were properly explained to it. He saw in the education of workers about ergonomics objectives a means of obtaining useful data for the medical officer and technician, thereby enabling them to carry out specific improvements to the work process and technical structure.

Dr Duncan

Dr Duncan asked Prof. De Groot whether he agreed that in matters of ergonomics the person selected to be in charge depended on the particular circumstances. It was Dr Duncan's view that doctors had no divine right to assume the leadership of ergonimics teams in all cases. In some cases the industrial medical officer was the appropriate choice, but not in others. Referring to a previous comment by Prof. Symanski, Dr Duncan pointed out that in the United Kingdom and the United States of America industrial hygiene had developed as a separate and independent science. Industrial hygienists were not medical ancillaries but scientists in their own right.

Dr Amoudru

Dr Amoudru congratulated Prof. De Groot on his lecture which had departed from the written text supplied and therefore, in his opinion, represented a considerable achievement. Modesty had obviously prevented Prof. De Groot from saying anything about the comprehensive ergonomics programme in "Hoogovens" in IJmuiden, though in fact Prof. De Groot and his team had accomplished work of the first order in the field of ergonomics.

Concluding remarks by Prof. De Groot

(In answer to Prof. Odescalchi's comments)

Qualifying the proposition that workers had hitherto not been sufficiently informed about ergonomics, Prof. De Groot stated that insufficient interest had hitherto been devoted to the actual work. There had been a preoccupation with working conditions but, strangely, the actual work had until recently not been considered at all. With reference to the comment that interdisciplinary cooperation was difficult, Prof. De Groot stated that, while he himself had been an almost consistent advocate of multidisciplinary activity, monodisciplinary activity was of course much easier. This brought Prof. De Groot to Dr Duncan's comment and his question as to who should lead an ergomomics team. Prof. De Groot was in full agreement that the medical officer had no God-given right to the leadership of such teams. As a rule, the medical officer was on the bottom rung of the works hierarchy, as he had little contact with the management. However, this in no way detracted from the fact that the medical officer's position within the works and the guarantee of his autonomy and independence encouraged mutual trust between him and the workers. This was sufficient argument for entrusting the leadership of an ergonomics team to the medical officer. If however he was incapable of discharging this leadership, and a works engineer commanded sufficient trust not only on the part of the management but also of the labour force, there could of course be no objection to someone other than the medical officer assuming the leadership of the team. Prof. De Groot terminated his replies to the comments that had been made by thanking his friend, Dr Amoudru, for his kind words.

THE EFFECTS AND PREVENTION OF NOISE

Dr. J.A. DICK, Rotherham

Although it has been known for a very long time that noise had some effect on hearing it has been accepted as a serious occupational health problem comparatively recently. Once recognised as such the problem of noise has received ever increasing attention from occupational physicians, management, unions and government. The Working Party on Industrial Medicine has a continuing interest in this problem and in his report to the Working Party, Professor Partch noted that problems arising from noise exposure took second place in occupational health problems in the Federal Republic and first place in the German Democratic Republic. In France the numbers of miners receiving compensation, because of excessive noise exposure, has recently increased and in the relatively recent past the problem of noise has been emphasised in the United States, Sweden, and Finland among others.

There is insufficient time to go into the physics of the problem. Briefly, sound consists of a series of presure waves in air, varying in amplitude and speed. Loudness of sound is measured by decibels and the speed with which waves travel through the air is measured by frequency. Noise may best be described as unwanted sound and this unwanted sound need not necessarily be related to loudness, but is dependent upon circumstances and environment. For example, the sound of a baby crying during the night is not very great, but nevertheless it certainly represents a noise to the listener, or the motorcycle on a quiet country lane represents a noise in that environment which would be unnoticed in a busy city. In the field of occupational health, noise has three effects; on accuracy of work, on safety and on health. It is with the latter that we are primarly concerned today.

It has been suggested that noise can be the cause of various somatic diseases; hypertension and blood disorders have been mentioned recently in Medical Journals as propably being influenced by noise, but as yet there is only one proven health hazard specifically attributable to noise and that is loss of auditory acuity or deafness.

A great deal of research has been carried out into this problem and it is now established that if an individual is exposed to a noise of 85 to 9o dB(A) or more continuously during an eight hour day, five day week, then deafness will occur, with the time taken to develop this disability varying with the individuals susceptibility to noise. I must emphasise that this refers to steady state noise. Knowledge of the effect on hearing of intermittent noise is much less accurate and largely theoretical. In a situation in which there are periods of excessive noise alternating with quieter periods the concept of equivalemt continuous noise (Leq) is used. This summates the periods of exposure to 85 dB(A) or more and translates the total into a figure which is considered to represent continuous exposure over an eight hour day. For example, a worker exposed to 85 to 9o dB(A) for four hours of an eight hour shift would have a Leq of 9o dB(A) over an eight hour shift.

The process of hearing can be considered as pressure waves being converted into fluid waves and these being converted into nervous stimuli, which are then interpreted by the brain as sound. The vital part of this mechanism, so far as noise is concerned, is the cochlea in which is situated the cells which convert fluid waves to nervous stimuli. In this organ there are groups of cells which accept stimuli representing different frequencies. Stimuli representing sound of an intensity up to 85 to 9o dB(A) are accepted by these cells without any detrimental effect, but repeated stimulation by sound or noise above 85 to 9o dB(A) will have a harmful effect on them. At first this is temporary and return to normal follows the removal of the stimuli. This phenomenon of temporary hearing loss, is known as temporary threshold shift, TTS). If, however, repeated exposure to such noise continues over a full working shift for a full working week then these cells do suffer permanent damage, which is represented by permanent hearing loss, permanent threshold shift (PTS). It is a physiological fact that the cells which deal with noise in the 4 kHz frequency are more susceptible to this phenomenon and it is in this frequency that the first evidence of threshold shift due to noise will be observed.

It has been established that the cells relating to the 4 kHz frequencies are more sensitive to excessive noise and most rapidly show evidence of damage to auditory acuity. The efficiency of an individual's hearing is assessed by means of an audiometer. This instrument allows us to measure the levels of sound necessary to reach the hearing threshold at varying frequencies. Clearly the greater the sound required the less efficient will hearing be at that frequency. Tests are usually carried out at the following frequencies ½, 1, 2, 3, 4, 6 and 8 kHz in a sound-proof booth. The threshold at each frequency for each ear is then plotted and the resulting diagram of auditory acuity is known as an audiogram. It will be clear that the first evidence of noise induced hearing loss will be seen at the 4kHz level and this evidence will be detectable by an audiogram before the individual is aware of any change in his hearing level, because the frequencies used in everyday conversation (½, 1, 2, 3 kHz) are not yet involved. As excessive noise continues , however, the adjacent frequencies become affected and the audiogram shows a widening and deeping of hearing loss with eventually the conversation frequencies being involved and social deafness occurring.

If these appearances in the audiogram were unique to occupational induced hearing loss the problem of diagnosis and hence compensation would be simple. But this is not so. Excessive noise from any cause (for example gun-fire) can produce the type of audiogram shown, as can certain diseases, drugs (streptomycin) and accidents to the head causing unconsciousness. These possibilities have to be considered before deciding whether loss of hearing acuity is due to occupational noise.

Although the hazard has been recognised for some time the response by individual countries has varied. In my own country for example occupational induced deafness is not yet recognised legally as an industrial injury. In 1974 the Government accepted the need to alter this situation, but as yet no Parliamentary action has taken place.

In those countries in which compensation is paid for hearing loss the criterion of disability is usually loss in the conversation frequencies, i.e., a social disability. This is calculated by averaging the loss in the ½, 1, 2 kHz or the 1, 2, 3 kHz, and relating the resulting figure to the table of degree of severity.

Average value of Hearing Levels at 5oo, 1ooo & 2ooo Hz

Class	Average Hearing Level dB	Degree of Hardship	Ability to understand ordinary speech
A	Less than 25	Not significant	No significant difficulty with faint speech
B	25 to less than 4o	Mild	Difficulty only with faint speech
C	4o to less than 55	Moderate	Frequent difficulty with normal speech
D	55 to less than 7o	Marked	Frequent difficulty with loud speech
E	7o to less than 9o	Severe	Shouted or amplified speech only understood
F	9o	Extreme	Usually even amplified speech not understood

In common with pneumoconiosis, noise induced hearing loss is largely an engineering problem. Just as pneumoconiosis would not exist if machines did not produce excessive respirable dust, so occupational deafness would not exist if machines did not exceed 85 to 9o dB(A) of noise output. The first step in dealing with the problem, therefore, is for occupational physicians and ergonomists to ensure that engineers are aware of the problems of noise and to press for noise limitations to be fully considered at the planning stage of machinery, (once a machine has been designed and produced it is more difficult and costly to apply noise reductions measures).

But there are at present many machines in operation, which may produce excessive noise, a hazard requiring preventive action by occupational doctors. The first step is to identify these machines with possible noise excess and to measure noise output from them with the appropriate instrument. Personnel exposed to excessive noise must be protected. Clearly the best method of doing this is to reduce noise output to below hazard level. This may not be technically possible and in that event attempts should be made to enclose the machine, or alternatively enclose individuals, or reduce individuals exposure time. Only if all these procedures are impractical should it be necessary to protect the individual. Individual protection can be with ear plugs, glass wool or ear muffs. It is our experience that ear plugs are unsatisfactory and disliked by the individual. Glass wool is easy to use, but it's attenuation of noise is less than that of ear muffs. It will be seen that if noise is 11o dB(A) or over ear muffs are necessary.

I can illustrate the practical application of these remarks by describing the action taken in a real situation by a large industrial concern. The health service at this concern has at its disposal two mobile units operating from a central laboratory,fully equipped to measure and analyse noise. This includes a tape recorder to record noise for later analysis at the central laboratory. In addition industrial noise dosimeters are carried by workers throughout the shift. By this means a noise map is produced and this in turn forms the basis for prevention measures. Some examples of the results of these measures are :-

Engineering works : Screw-making machine fitted with sound absorbing housing. As result reduction in noise level from loo dB(A) to 8odB(A).

Iron foundry : Sound-proof and air-conditioned control cabinets for certain operations. In various shops numerous relaxation points, noise-proof and air conditioned for workers use in break periods.

Non ferrous metal foundry : Housings round machines in bar and strip shops and sound-proof cabins.

Thermal power stations : Sound-proof cabins for protection of operators.

Car assembly plants : Sound-proofing of small pressing shop by absorbing panels. Replacement of portable drills with lo2 dB(A) to 95 dB(A) by drills with only 83 to 85 dB(A) noise levels. Reductions of lo to 2o dB(A) have been obtained.

Clearly given the equipment the active occupational doctor could do a great deal to overcome this industrial hazard. As I have already said noise is a relatively recently recognised problem and a great deal of research into its problems is still required. The engineers must continue their efforts to reduce noise output from machines and ergonomists should be given a greater part to play in the planning of factory lay-out so as to reduce levels of noise exposure to a minimum. Medically we need to know a great deal more about individuals susceptibility and about the effect of discontinuous noise. For example, in the mining industry the nature of operations is such that coal cutting machines operate spasmodically throughout the shift and although many of these machines do have noise outputs of more than 9o dB(A) it does not appear that the Leq for an eight hour shift is more than 9o dB(A).

Research on the possible part which noise may play in the causation of other somatic diseases is urgently required. Finally and perhaps most important we need to establish an agreed normal hearing level for the young non noise exposed ear. The latter two problems might well be carried out on a European basis.

NOISE CONTROL AT FIAT S.p.A.

Dr. E. CASALONE, Torino

The problem of noise in and outside the factory, and of the disadvantages resulting from it, has become particularly noticeable in recent years. It was the ear specialists, occupational doctors and ergonomists who drew attention to the problem, and representatives of both employers and employees were very eager to discover possible solutions.

The alarm, was raised, in fact, a considerable time ago. But as the problem of noise is frequently a difficult one to solve, progress has been slower than in other environmental health fields.

It is in fact common to see new industrial plant where the working conditions with respect to microclimate, air pollution, lighting and fatigue are of a very high standard, the only defect being a high level of ambient noise.

To date the greatest portion of the noise control campaign has tented towards correcting the existing ambient noise situation although a start is being made on the design of quiet plant.

In my company noise control has been systematized since 1971. I should like to describe this, as I think it may supply some interesting information.

Noise control is based essentially on three prime objectives :

1) Investigations and surveys into industrial noise in the plant;
2) Medical prevention of noise-induced injuries ;

3) Technical precautions taken or to be taken on the basis of the results of the noise surveys.

INVESTIGATIONS INTO INDUSTRIAL NOISE IN OUR COMPAGNY

The first environmental investigation into works noise in our company was held at least 15 years ago, and a fairly extensive survey was carried out in 196o; the ambient noise level in a plant was measured and audiometry applied to the staff.

These initial investigations were not systematic and the sound level was only measured on certain occasions. Gradually, however, they became more frequent and systematic and from 1971 onwards their principle was incorporated in trade union agreements.

In fact in the agreement drawn up in that year between the company and the workers' representatives it was laid down that in all sections of the company, as selected by the workers' representatives and the company's technical services (in particular, the factory health service) systematic surveys would be carried out of the following environmental factors :

1) gas, fumes and dust in the air
2) climatic conditions, lighting
3) noise, vibration.

The first stage is a preliminary study by the persons referred to above of the individual departments of the works to be examined, and from this the environmental factors to be examined, the working locations to be studied and the aim of the environmental investigation are laid down.

The conclusions drawn from the survey will gain in precision proportionately with the suitability of the unit of measurement slected for the assessment of the parameter under examination : the dB (A) is preferable for measuring an overall sound level, while evaluation of the disturbance caused by noise will require a fairly extensive analysis by octave bands to determine the S.I.L. (Speech Interference Level) number and in third bands to identify the characteristics of a noise source.

The reference values used for risk evaluation purposes are those of the "Report of Working Group 46 NAS-NRC" published by the Committee on Hearing Bioacustic and Biomechanics (CHABA) in 1965.

Following such surveys, and in order to meet their requirements, the company created under the Central Research Department a specialized department known as Ecological Control, whose principal responsabilities included the checking of the chemical and physical pollution conditions of the working environment.

This department was divided into two groups, the second being concerned with checking physical environmental factors, and noise in particular.

The group is equipped with three van-mounted mobile stations, enabling surveys to be carried out at different working locations, and a central physics laboratory containing instruments to analyse and elaborate the data collected by the mobile stations. Two of the three mobile stations are equipped with an analysing unit in thirds and octaves, a graphic sound level recorder and an oscilloscope for visual study of the phenomenon (this also helps to avoid errors due to electromagnetic interference), and a magnetic tape recorder on which are recorded the production cycles which have a high noise level and are of long duration.

The third mobile unit, unlike the first two, is equipped with a complete setup for recording and analysing the frequency of the vibrations, composed of accelerometers with relative amplifiers, and a frequency modulating magnetic tape recorder for the subsequent laboratory elaboration of the assembled data.

The surveys in the various locations are also carried out with a microphone placed near the ear of the worker and connected by cable to the mobile unit.

The central laboratory is fitted with all the equipment required for the analysis and elaboration of the data collected by the mobile stations.

The sound levels at the various frequencies are read, their relative duration, and the spectra thus collected are applied to the graph of CHABA curves in order to trace the sound level curve and enable comparison with the limits advised by CHABA.

A second assessment is carried out, compiling the table proposed by the American Conference of Governmental Industrial Hygienists (A.C.G.I.H.), which determines the exposure times to the sound levels by comparison with the permitted levels.

The laboratory is also equipped with a General Radio real-time analyser in thirds and octaves which can be transported to the working location to analyse the noise there and identify its various individual sources in order to indicate the precautions to be taken; to assist in the choice of sound-absorbent materials a stationary wave measuring device or Kundt tube is also provided.

As an alternative to the methods described so far, recording can also be carried out by individual dosimeters which are worn for the whole of his shift by the worker under study.

It is thus possible to compile charts of the noise in the various plants, and these can be used both for noise prevention measures at source and to assist the works doctor in deciding on individual protection for the workers.

The surveys carried out by the Ecological Control laboratory are entered in an "ambient data register" which is placed at the disposal of the workers' representatives, enabling them to discuss with the management of the unit studied the precautions which ought to be taken.

MEDICAL PREVENTION OF NOISE-INDUCED HARM

Examination on employment : in order to ascertain whether their case history at the time of the examination contains significant cases of prior exposure to noisy work or of reduction in hearing, an ear, nose and throat examination and audiometric study are carried out on all new employees, in addition to these examinations form part of the preliminary medical examination which involves a general clinical examination, various special examinations and laboratory tests.

The audiometric study is carried out in a multiple soundproof cabin with room for 12 persons, and involves trials at the standard frequencies of 5oo, 1 ooo, 2 ooo and 4 ooo Hz.

Naturally, if the survey shows up a hearing defect, a complete audiometric examination is carried out.

The employee's medical records follow him to the various plants, and the works doctor, basing his opinion on the results advises the personnel department on the working locations where he may be most suitably assigned.

The practice of carrying out an audiometric study on new employees dates from about five years ago, i.e. the beginning of 197o, but at first it was carried out only on those who had some difficulty in hearing speech.

<u>Periodical examinations</u> : since then,gradual progress has been made in equipping the medical services of many works with audio metrical cabins and audiometers. On this topic it may be pointed out that the first investigations into persons at work in noisy environments in our company began in 196o.

Nowadays all the major works are provided with audiometric equipment, and the works medical department have a technician at their disposal whose task it is to carry out the audiometric studies or, if necessary, complete audiograms on those involved in noisy production processes.

The personnel undergo such examinations periodically : every two years for those without hearing defects, otherwise more frequently. Basing his decision on the results, the works doctor can have workers suffering from a reduction in hearing or with medical trouble attributable to working in noisy conditions removed from such working locations, and can also indicate to the insurance association and the works inspectorate those workers whose hearing loss entitles them to compensation. But above all he can initiate surveys of the ambient sound level, into the technical measures which can be taken to reduce it and can prescribe and publicise the use of individual protectors in all those working locations where noise reduction at source is very difficult or is planned for a too long time ahead.

the subject of individual protection measures, it was noted that the workers regarded them with hostility or indifference.

In an attempt to persuade the workers of a large unit to use individual hearing protectors, meetings were held between the works doctor and groups of 2o-25 workers, with the purpose of illustrating briefly how deafness arises at work, and the characteristics of the various hearing protectors. The personnel attended with considerable interest, but the suggestion that they should use hearing protectors met with less interest. A survey carried out in the same works to ascertain the reasons given for the refusing to use hearing protectors gave the following replies, in order of frequency :

1) general reluctance
2) headache
3) heat sensation in the ear
4) dizziness on remowing the hearing protector
5) reduction in speech comprehension.

The hearing protectors currently in use in our company are mainly wool padding plugs or plugs made of a special plastic foam. They are both fairly selective, filtering out 25-3o dB at high frequencies (3 ooo - 4 ooo) and 15-2o dB at lower frequencies. Ear muffs are used in special cases where their use is perticularly recommended, and helmets are virtually not used at all.

SPECIAL TECHNICAL PRECAUTIONS BASED ON THE RESULTS OF THE SOUND LEVEL SURVEYS

Concurrently with the environmental surveys, gradually increasing use has been made of technical measures aimed at correcting situations with an abnormal sound level, the culmination in recent years being the institution of technical units responsible among other things for designing anti-noise systems : for example, affiliated to the central laboratories of the Central Research Department are the SITECO and Costruzioni e Impianti S.p.A. Fiat Engineering.

This step has proved to be necessary on the one hand because production plant designers often found that outside suppliers structures were not quiet enough, on the other hand in order to correct features of plants which were already in operation, but were too noisy.

This developed in accordance with two principal objectives :

1) preventing noise from disturbing the atmosphere around the factory;
2) controlling noise disturbance in the factory itself.

The precautions which can be taken are as follows :

- covering the workshop walls and ceilings with sound-absorbing panels, or fitting baffles;
- the use of mobile sound-absorbing panels to isolate individual noisy production processes, or isolating noisy sections from the rest of the workshop by means of sound-absorbing panels;
- applying sound-absorbing cladding to noisy machiners;
- reduction of the sound level by work on details or features of the machinery itself.

By way of example, I shall list some of what has been done or is at present in hand.

Cold rolling plant : covering upsetting machinery with suitable sound-absorbing cladding, ventilated so as to give numerous air changes to dispose of both the oil fumes which occur and the excessive heat originating in the machines themselves.

The sound level, which on uncovered machines was in excess of loo dB (A), dropped to about 8o dB (A). To date 7o such claddings have been constructed, and when the operation is finished the total will be 24o.

Cast-iron foundry : production of sound-proofed and air-conditioned control cabins.

In the processing departments, the establishment of numerous sound-proofed and air-conditioned rest areas which the workmen use during their breaks.

Non-ferrous metals foundry : covering the rod spot welders and strip shearers with sound-proofed cladding.

Heating plant : installation of sound-proofed cabins to protect the operators in the plant itself.

Car assembly plants : sound-proofing, by means of sound-absorbing panels, of the ceiling of a small press shop;

replacement of compressed-air or high-frequency screwdrivers and drills having a sound-level between 95 and lo2 dB (A) by others with a sound level of no more than 83-85 dB (A);

attenuation of the compressed-air noises from presses achieving sound-level peaks close to 12o dB (A) - attenuations of lo-2o dB (A) have been achieved.

This list could continue further.

I will restrict myself to quoting Fiat internal standard of 1973 no.9.7olo6 referring to the acquisition of equipment which recommends that any new equipment should have a sound level no higher than 85 dB (A) at a distance of 1 m from the equipment or at the ear of the operator, this level being reduced to 82 dB (A) if the noise consists of pure tones.

At this point I think that the most useful thing to do would be to show some slides which I will attempt to explain as we go along.

DISCUSSION

First speaker Prof. Odescalchi :

Prof. Odescalchi pointed out that the papers had once again referred almost exclusively to the harmful effects of noise on workers' hearing and that insufficient attention had been paid to the harmfull extraauricular effects.

Agreeing with Prof. Odescalchi the second speaker, Dr Jolivet recalled that at the Turin Conference on noise reference had been made to experiments showing the pathological effects of noise on vision. Individuals exposed to high noise levels had shown adjustment and perception difficulties. Dr Jolivet considered this an important fact since workers exposed to high noise levels could not recognise signals and were consequently put at considerable risk.

Dr Muir drew a comparison between the points raised in the previous day's lectures and the afternoon's comments on diseases attributable to noise effects. Prof. Casalone's paper had dealt with the detection of sources, thereby clearly raising the question of prevention. The source must be detected and eliminated, in order to prevent hearing defects which could not be treated in any other way. In the United Kingdom and the USA the use of the term "prevention" (Prävention) did not correspond completely with what had been said the previous day concerning prophylaxis (Vorbeugung). In English "prevention" referred only to the detection and elimination of the causes of diseases. In general this did not entail the subsequent identification and treatment of cases that developed into disease. Prof. Minette had drawn attention to the importance of "Prävention" in the practice of examining the pulmonary functions. This was undoubtedly significant but resulted in confusion amongst English-speaking participants, since it involved a different type of prophylaxis from that associated with "prevention" in English linguistic usage.

SUMMARIZED REPORT AND CONCLUSION OF THE CONFERENCE

(Professor P. SADOUL)

To summarize the ideas and conclusions of a two-day meeting devoted to consideration of the results of a four-year research and development programme in industrial medicine seems to me to be an exceedingly difficult task.

In his outstanding introductory address, Mr Recht very rightly recalled how the first research committee met more than 2o years ago to launch our first research programme. How far we have come since then! As you said, Mr Recht, we have seen "the advent of outstanding international scientific cooperation whereas in other fiels, European research has not yet found its feet". Thanks to a succession of European Community research programmes, there have been frequent meetings of researchers. Friendships transcending national boundaries have been established cooperation has been a real pleasure and, in this field, the wishes of the founders of Europe have been fully realised.

One of the aims of this symposium was to enable researchers to inform producers, workers and industrial medical officers of the progress and new developments achieved by the research carried out between 197o and 1974.

Basic research was carried out in many fields which are not always easy to summarize. The importance of research on the alveolar macrophage not only in animals but in human beings should be stressed. The in vivo culture of these macrophages permits better definition of the cytotoxicity of certain substances. The effect of quartz on the immune defence of the body is complex. If bacteria such as atypical mycobacteria, are administered at the same time as quartz the immune response is increased. But if the quartz is administered at some interval of time from the antigen injection, the result is immunosuppression. Coal dust has the same effect but to a much lesser degree.

The toxicity of dusts may be related to their electronic structure as well as their chemical nature. This may throw some light on the varying hazards of different mines. The cytoxicity of dusts is much more marked if derived from very old geological structures. In addition to quartz and coal, the toxicity of other dusts is still being studied.

The toxicity of dusts is however only one aspect of the problem of the aetiology of pneumoconiosis and chronic respiratory diseases. The sensitivity of the respiratory system to dusts and toxic agents is also related to multiple endogenous factors which explain the varying susceptibility of workers to occupational risks. Experiments on pathogen free animals have shown that infection is one of these factors. Immunological and constitutional factors at present being studied lead us to hope that it will one day be possible to avoid exposing individuals to occupational risks to which they are particularly susceptible.

There have been interesting animal experiments concerned with emphysema which is so often associated with pneumoconiosis. If animals inhale papain, an experimental model very close to the emphysema observed in man is obtained. Judging from morphometric studies it would seem that there are two types of emphysema, one caused by the destruction of the inter-alveolar walls and another by atrophy and subsequent distension of the alveoli. It is known for example that emphysema is much more likely to occur in subjects deficient in proteins with antiprotease activity such as alpha 1 antitrypsin, either because of the effects of smoking or because of the release of certain proteocytic enzymes during repeated superinfections.

The tracheobronchial system plays a primary role in the defence against dusts. Studies using labelled particles show that bronchial clearance varies from one subject to another, taking several hours in some cases and lasting up to two days in others. Mucociliary clearance is affected by many toxins including tobacco smoke. In addition, the bronchial secretions themselves affect the speed of ciliary clearance. The variations in the biological properties of sputum are very great; viscosity can vary in a ratio of 1 to 5o and the elasticity of the sputum also varies considerably. The chemical composition of bronchial secretions is highly complex. Some substances inhibit bronchospasm caused by bradykinin, others, however, themselves cause contraction of the bronchial musculature. We are beginning to recognise the important part in the defence mechanism of the bronchial tree played by immunoglobulins A in the secretions. There is no doubt that these studies of bronchial secretion and mucociliary dynamics will lead to important therapeutic implications in the relatively near future.

PVNO has raised great hopes and justifiably so since, for the first time, it has been possible to check the development of silicosis by a specific agent. Its action was discussed at length and Professor Worth, in his synthesis, emphasized the importance of this substance and the hopes it has raised. Experiments must certainly be continued and it has yet to be shown that it is free from side effects. With a chronic disease requiring long-term treatment, several years of follow-up is essential.

Research has been carried out in the field of respiratory physiology to find simple methods of functional assessment and, on the other hand, to increase our understanding of the abnormalities in pneumoconiosis and occupational lung diseases. In these illnesses there is often increased airway resistance affecting particularly the small airways in the early stages. Unfortunately the usual methods of investigating these abnormalities are complex and require complete and prolonged cooperation by the subject being examined. Industrial workers, unlike physiologists, are not laboratory animals! We therefore have to find more simple techniques. In addition, the instruments must be meticulously maintained and checked. Since conventional plethysmographic methods are still rather sensitive the current interest in oscillometric methods which depend less on the subject's cooperation is readily understood. Similarly the interruptor technique, which has been known for some considerable time, is claimed to be a simple means of assessing to what extent the small airways are affected. It is even claimed to measure the closing volume more easily than the tracer gas method, the technique usually employed in the United States.

Intrapulmonary gas distribution is not assessed merely by the closing volume, which is known to have its weak points, but also by helium distribution curves. A portable analyser has been developed under an ECSC research contract which could be used at workplaces to detect disorders caused by inhalation of toxic dusts and gases.

The importance of tests using carbon monoxide has sometimes been obscured by the physiopathologists advocating their use. Although attempting to obtain information on the mechanisms of disorders from these investigations, they sometimes become lost in interminable discussions about the technical methods of the tests or the manner of expressing the results. Leaving aside the disputes between the various schools of thought, we may conclude that the coefficient of CO uptake or CO transfer obtained during steady state measurements and the TCO/AV ratio obtained by the breath-holding technique give a fairly accurate picture of abnormalities of respiratory gas exchange. Both are reduced with age and if pneumoconiosis or emphysema lead to functional respiratory deficiency. For the purposes of standardization, the limits of the normal values for these two coefficients must be defined since they are still a matter for dispute in spite of all the efforts that have been made.

Exercise tests are essential for adequate assessment of functional respiratory deficiency. This is particularly so in the case of pneumoconiosis, thoracic trauma or the results of chronic respiratory diseases such as tuberculosis. Unfortunately these exercise tests involve high staff and equipment costs. There are as many types of exercise as there are laboratories and the variables measured vary from one centre to another. For this reason Community researchers have in recent years concentrated on "triangular" exercise tests, i.e. effort which increases steadily with time. It seems fairly clear that two tests of 15 to 25 minutes for each subject provide a sufficiently accurate assessment of his physical fitness. Here too,however, research must be continued, particularly to find out whether measurements on healthy subjects provide information of practical value to the handicapped patient.

Respiratory physiopathology does not aim only to perfect research methods for use by epidemiologists or by experts in functional assessment. It also involves trying to understand the nature of the physiological abnormalities in different pulmonary diseases. Detailed studies carried out in well-equipped centres have shown that, in addition to symptoms of the bronchitic type, there are other abnormalities, particularly affecting gas exchange and a reduction of the vascular bed. The Brussels meeting, promoted by the High Authority, showed the great variability of functional abnormalities occurring in micronodular pneumoconiosis. It is impossible to assess the state of respiratory function simply by inspecting radiographs. This is not surprising if one considers how many different anatomicopathologic lesions correspond to a given radiological type of pneumoconiosis.

Epidemiological studies have confirmed, as if proof were necessary, the great importance of using questionnaires and measuring the FEV_1. Applied to carefully selected samples, they have helped to show that a number of simple functional tests could be used on a large number of subjects. They have confirmed the harmful effects of mixed pollution; pollution by dusts and gases at the workplace on the one hand and on the other, non-occupational factors such as tobacco, living conditions and atmospheric pollution in the neighbourhood. Epidemiologists certainly cannot disregard pollution levels in the working environment or in the neighbourhood atmosphere at home. In view of the complexity of measurement techniques and the need to identify pollution peaks, they must collaborate with air pollution specialists and discuss the planning of their research most carefully to ensure the validity of their results.

Prevalence studies have shown that 25-30% of steel workers have chronic respiratory disorders and the corresponding figure among coal miners was much higher. When pneumoconiosis is present, dyspnea, which is normally more frequent in miners than steelworkers, becomes even more severe and widespread. It is clear that research is still necessary to obtain better correlations between respiratory disorders and defined working conditions, particularly with regard to pollution levels.

Longitudinal epidemiological studies have shown that 20% of men who coughed occasionally developed chronic bronchitis five years later. But in addition to information provided by the questionnaire, the reduction of the forced expiratory volume in the first second also had predictive value. Even in symptom free subjects, such a reduction has been shown by long term studies to indicate that deterioration of the respiratory function will occur eventually. Such deterioration is much more frequent when workers are subject to repeated pollution. These longitudinal studies must be continued in order to obtain more information on the risk factors and to identify the earliest signs of pulmonary damage.

Early detection of functional abnormalities will be a particularly important result of epidemiological studies since the problem of persons over 5o years old with respiratory insufficiency is often encountered by the industrial medical officer. At present, when he sees a man with respiratory disability it is often too late to treat, rehabilitate or find alternative employment for him. The lesions have been forming for years, have become irreversible and have led to serious functional damage, although this is too often underestimated. We must remember that those who suffer from severe respiratory insufficiency are just as handicapped as a worker who has lost the use of an arm and that their incapacity is much more serious than that of a man with only one eye. If the industrial medical officer is unable to detect respiratory insufficiency before it becomes irreversible, social deprivation will be the lot of fan to many workers.

The episodes of bronchial infection which so often complicate pneumoconiosis, chronic bronchitis and emphysema are often given inadequate treatment. The bronchial tree of these subjects is particularly sensitive to infection. Often the mucosal defence is inadequate and basic studies on bronchial secretion in these patients show that the secretion it has, to some extent, lost its defence potential. The mucosa can thus be regarded in this respect as being non-functional. Before this stage there is often bronchial hyperreactivity which is very easy to detect by the acetylcholine test. Bronchospasm later plays its part in the development of bronchial infection since it hampers bronchial clearance. Infection itself must be prevented and treated. Preventive measures usually consist of vaccinating against virus infections which often result in mixed bacterial infection. The often indiscriminate use of antibiotics by general practitioners has led to the appearance of new microorganisms not formerly occurring in the bronchial tree and resistant strains which are more difficult to combat. This practice has undoubtedly encouraged the occurrence of mycoses which were formerly very rare. Systematic surveys have shown the danger and futility of overprescribing drugs in chronic pulmonary disease. I shall not refer to PVNO treatment here since it is still at the experimental stage.

The doctor must think about rehabilitation as soon as the illness begins. It is an essential complement to conventional drug therapy. Regular medical supervision and normal hygiene and dietary measures such as abstention from smoking and weight control are considered to be part of rehabilitation by some doctors. While this attitude is not strictly correct, it does remind us that rehabilitation must be borne in mind throughout the supervision and treatment of the patient. In addition to respiratory physiotherapy, the techniques of which are now better understood, programmes of work retraining have been proposed which improve the patient's physical condition while enabling him to achieve the best possible respiratory function despite damaged lungs. Physiotherapy and training in the correct amounts certainly do not worsen the patient's condition. They lead to an increase of maximum oxygen consumption and improved performance. It would seem that more efficient use is made of the oxygen reaching the tissues by a patient who has followed a rehabilitation programme. Physiotherapy and work retraining should be continued for a long time since it cannot be hoped to achieve optimum function after a only few sessions, in view of the mechanical disorders of the lung. From following up patients for several years after a rehabilitation programme it appears that their development is distinctly better than patients who have not been rehabilitated. Their pulmonary arterial hypertension at rest and during exercise does not worsen. In the course of years, patients with chronic pulmonary diseases often develop right ventricular insufficiency, but this occurs later in those who have followed a respiratory retraining programme. No matter how encouraging the results may,be they could be greatly improved if patients with respiratory handicaps were sent to a medical rehabilitation specialist much earlier. They must therefore be detected in time. Since as a rule they rarely consult general practitioners, the industrial medical officer must develop some system of early detection a programme of health education for the workers in his care.

The United Kingdom coal industry began an extensive survey on miners' health in the fifties. As early as 1952 an epidemiological study was started on about 3o ooo miners. Virtually all the miners in selected mines underwent regular X-ray examinations and, in recent years, tests of lung function. The questionnaire, a favourite tecnique of our British friends, was of course employed with simultaneous detailed estimates of the exposure of each worker in the ambient air. This very complete long-term survey will certainly provide information of great value to specialists in coal workers' pneumoconiosis. According to Article 55 of the Treaty establishing the European Coal and steel Community, the High Authority was to initiate and promote research into the health, hygiene and safety of workers. In order to make such research effective, there was to be collaboration between researchers and practitioners, scientific institutes and industrial medical officers. With this in mind, a Working Party on Practical Information for Industrial Medical Officers was created as early as 1956 and later became the Working Party on Industrial Medical Services - Coal and Steel. Its mandate which was at first somewhat sketchy, has been more clearly defined over the years. On the one hand it informs the higher authorities of the Community of the practical problems encountered by industrial medical officers in the coal and steel industries and,on the other, it provides information to industrial medical officers, employers and employees of the practical results of the research programme. It thus plays an essential part in obtaining the collaboration of new specialists, proposing subjects for research and persuading industrial medical officers to make use of the information obtained by researchers.

Since industrial medicine may pride itself on going right back to the very origins of medicine, it may seem strange that it is still necessary to define its role in the factory. It befell Drs. MELIS, KNIEB and DE GROOT to define the role and functions of industrial medicine in industry. Prevention and safety are evidently one of the vital tasks of the medical officer but he is now trying to do more, such as improving the working environment in order to increase the physical, mental and social well-being of the workers. It is therefore his task to apply ergonomic principals to define for each industry that environment which will be most comfortable and productive for the workers. In doing so, he in no way oversteps his authority since the maintenance of workers' health is one of his essential tasks.

There are, however, many obstacles in his path. Too often industrial medicine is misunderstood.Some tend to regard it as a means of repression or a tool of management. If, however the medical officer acquires more profound knowledge of occupational risks, both worker and employer will begin to understand his role since his competence will command respect. This improved knowledge of occupational risks is essentially the culmination of a lengthy process extending from the time when workers in the Middle Ages first became aware of the dangers to which they were exposed until the formation of trade fellowships or associations aiming to protect workers' legitimate and basic interests in various European countries.

It is strange that although all industrial companies have an very important legal department or claims office, they often lack an effective medical organization or misunderstand its role. The company sometimes attaches a particular importance to curative medicine although this does not fall within the sphere of industrial medicine. This is sometimes encouraged both by the industrial medical officer himself and by the paramedical staff who often feel a sort of nostalgia for curative medicine. As a result they neglect physiological and occupational hygiene problems and fail to make adequate provisions for the rescue work which is their responsibility. Training of rescue workers in first aid has not always been encouraged by occupational training organizations. In the mines, where such training is often very good it is generally attributable to local initiative. It is obviously necessary for such paramedical staff to benefit from continuous training and to have prospects of promotion.

It might also seem strange for this symposium to include the pre-employment examination which would seem not to present any problems. In fact European authorities will have to pay more attention to this important problem now that the free circulation of workers is ensured. As Dr Amoudru emphasized wage earners should be guaranteed the same pre-employment medical examination in the host country as in their country of origin and be certain that the same opportunities will be open to them. A large-scale survey carried out among medical services in mines and steel works obtained information on 89 companies and 7oo ooo workers. An employment medical examination is statutory in four Community countries. For 75% of the workers involved it precedes employment. The number of subjects considered unfit varies widely from one place to another. If the average rates for the coal and steel industries are comparable (5.5%), the range of variations is very wide, from 2 to 16% for most companies. Evidently the selection criteria used are not the same. The elimination of a high proportion of applicants raises social problems. The unsuccessful applicant is not always given the proper attention and often the industry considers that it is none of its concern. Organisations able to take care of these unsuccessful applicants are few in number and overworked.

The pre-employment medical examination provides a report on the worker's state of health at the time of his joining the industry. It will serve as a basis for comparison at later regular examinations and also provides a good guide for the worker. For this reason we may well wonder if, at least for employment at workplaces which involve occupational hazards, it would not be advisable to carry out, in addition to conventional X-ray examinations, simple respiratory function tests to detect abnormalities which would not be shown up by clinical examination or by questions which are not necessarily answered accurately by the applicant.

Dr Dick emphasized that the damaging effects of noise have only been studied fairly recently. Although the results of exposure to levels greater than 9o decibels over an 8 hour daily period on hearing are well known, the effects of intermittent exposure are less well understood and methods of calculating equivalent noise levels are disputed. It is essential to make precise measurements of the noise levels in different work places;they are as necessary for the prevention of deafness as are dust measurements for the control of pneumoconiosis. The precision techniques described by Dr CASALONE demonstrated that these can be carried out in the factory. Many machines emit noise greater than 9o decibels, often they can be replaced by machines having noise emissions less than 8o decibels, which although still disagreeable, is less hazardous.

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The last few days have been the occasion for friendly meetings between research workers and industrial medical officers. They have exchanged practical information in order to guide their futur work. By learning of the industrial doctors' needs the researchers can concentrate on the really important problems while the many research results provide the doctors with new methods of investigating and treating health problems in workers. The importance of following this common effort is clear. It is essential for the European Community that the research projects continue, it is essential for the stability of the research groups which have been established that there should not be more than a few months between two programmes.

Complex scientific research cannot survive repeated interruptions. Cooperation between research groups in the different countries of Europe is now well established, this is the result of successive programmes carried out over 2o years. This fact deserves to be emphasized yet once more as the meeting is closed.

CLOSING ADDRESS

(Dr. P. RECHT)

I should like to express my thanks to Professor Sadoul for his fine report which summarized the problems of medical research which we have discussed here in the last two days. My task is now much easier, as his summary represents an excellent conclusion to our conference. He mentioned Article 55 of the ESCS Treaty which is the basis of the Commission's work and of the impetus which has been given, thanks to producers, employers and doctors, to the encouragement of health measures in the coal and steel industries. This article has a profound human and social significance, and in the two days that we have been together this aspect has been particularly stressed. Without doubt the conclusions drawn from this work have shown that in this particular sector, namely industrial medicine and accident protection, the efforts made have been remarkably fruitful, and that thanks to the good will of the scientific community in Europe, and for the greater good of the workers, remarkable cooperation has been achieved between the research workers and the doctors who have to apply the results of their research. And so, as this conference comes to an end, we have the enjoyable opportunity of observing the positive results of an initiative which is now some 2o years old and which grows in strength from year to year.

I should like to take this opportunity of commenting on the significance of the problems which have been highlighted during today's bird's eye view of the present state of industrial medicine. We are up against difficulties which have been noted in all sectors of medicine, but particularly in the sector of what is commonly known as preventive medicine. The rôle which this form of medicine occupies in the overall medical scheme has not yet been defined, and the ideas we have heard today will serve as topics for future meetings and for possible action by the Commission when the time comes to spread its activities beyond the coal and steel industries. It is important to bear in mind that the population of our nine nations in Europe is now 264 million, of whom the civilian work force numbers 1o4 million, 4o% of them in industry, a little more than 4o% in service trades, and about 1o% in agriculture. This means that the field in which industrial medicine must operate is vast, and the work of the Commission in this respect must be equal to the problems which arise, and at the same time must be a model for such work. Industrial medicine is going through a difficult phase; it must find its impetus and direction again, and we must adopt a common Community approach, which does not exist at present. This is the line which we intend to pursue, using the extremely useful analyses which have been presented by our eminent rapporteurs. I should like to thank all those who have contributed to the success of this conference; first of all the two session chairmen, Dr Foehr and Dr Vidali, who directed the exchange of intricate and complex views with skill and competence, guiding discussion towards the topics we had chosen. I should also like to thank Dr Hentz, who organized this meeting so well and to express in your name our gratitude to him and to all those who assisted him in making this conference a success, not forgetting Mme Hentz who organized the ladies' committee with such efficiency and kindness.

Finally I should like to offer my thanks, not only to Mr Sadoul to whom we paid tribute just now, but also to all those who, thanks to their outstanding knowledge of the problems, were able, whether as speakers or by their presence, to transform this meeting into a notable contribution to the progress of medical research in a Community which we may cite as an example for the quality and profoundly human value of the results it has achieved in the realm of health protection.

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